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A Profile of the Fish and Decapod Crustacean Community in a South Carolina Estuarine System Prior to Flow Alteration

Elizabeth Lewis Wenner, Malcolm H. Shealy, Jr.,
and Paul A. Sandifer

March 1982

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U.S. DEPARTMENT OF COMMERCE
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A Profile of the Fish and Decapod Crustacean Community in a South Carolina Estuarine System Prior to Flow Alteration[1]

ELIZABETH LEWIS WENNER, MALCOLM H. SHEALY, JR., and PAUL A. SANDIFER[2]

ABSTRACT

The seasonal distribution and abundance of fishes and decapod Crustacea collected by 6 m otter trawl from the North and South Santee Rivers, South Carolina, were examined over a 2-year sampling period. Species richness was greatest during summer and at stations located in proximity to the river mouths. Although species richness was found to be related to salinity, temperature, depth, and dissolved oxygen, it was most noticeably affected by a spring freshet which considerably lowered richness and abundance.

Eleven species accounted for 93% of the number and ~70% of the total fish biomass taken in both rivers: *Micropogonias undulatus, Anchoa mitchilli, Bairdiella chrysoura, Stellifer lanceolatus, Ictalurus catus, Cynoscion regalis, Dorosoma petenense, Leiostomus xanthurus, Trinectes maculatus, Brevoortia tyrannus,* and *Symphurus plagiusa.* White shrimp, *Penaeus setiferus*; brown shrimp, *P. aztecus*; and blue crabs, *Callinectes sapidus*, comprised over 96% by number and weight of the decapod fauna collected in both rivers. Dominant fishes were present in fairly equal abundance throughout the year and utilized the Santee system as either a residential or nursery area, while *P. setiferus* and *P. aztecus* were more seasonal in their pattern of appearance and abundance.

Length-frequency analysis showed the Santee system fish fauna to be composed mostly of juvenile specimens. Their presence throughout the year indicated that the Santee is a temporally stable and relatively nonstressed system and an important nursery area.

The predominance of juveniles accounted for lower biomass (kg/ha) of fishes in the Santee system compared to values for other estuaries along the Atlantic coast of the United States. The continued importance of juvenile fishes and shrimp in the Santee system is questionable in view of salinity changes in the nursery habitat following proposed river rediversion.

INTRODUCTION

A number of published accounts are available on community ecology of estuarine fauna along the northeastern and southeastern coasts of the United States. Despite this, few comprehensive studies exist on distributional patterns and faunal composition of estuarine megafauna, such as fishes and decapods, from a system which has experienced as many manipulations as the Santee River, S.C. The drainage basin of the Santee encompasses 41,000 km^2 in North and South Carolina. The Santee was the fourth largest river on the U.S. east coast prior to diversion of most of its flow into the Cooper River in 1942. Diversion not only lowered the annual mean discharge from 525 m^3/s to 74 m^3/s but also caused severe shoaling in Charleston Harbor at the mouth of the Cooper River (Kjerfve and Greer 1978). Changes in the amount of freshwater flow completely altered the supply and deposition of sediments, erosion patterns, salinity regime, flooding characteristics, and floral and faunal communities (Kjerfve 1976). After diversion, the salinity in the Santee distributaries, the North and South Santee Rivers, increased sharply. In addition, large quantities of fine-grained suspended sediments were transported into the Cooper River and, eventually, into Charleston Harbor.

The costly necessity to dredge Charleston Harbor continuously prompted a rediversion project begun in 1975 whereby 80% of the Cooper River flow eventually will be directed back into the Santee system (Kjerfve 1976). Upon projected completion of rediversion on the North and South Santee Rivers is purely 428 m^3/s (Kjerfve and Greer 1978). Although the impact of rediversion on the North and South Santee Rivers is purely speculative, it is likely to reduce the net salinity in the Santee system and increase amounts of fine-grained suspended sediments. Kjerfve and Greer (1978) cautioned that these combined changes may ultimately end the economically important American oyster, *Crassostrea virginica*, and hard clam, *Mercenaria mercenaria*, fisheries flourishing at present in this river. The effect of rediversion on fishes and decapod Crustacea also may be substantial. Shealy and Bishop (1979) suggested that population changes in penaeid shrimp may occur, and the extent of nursery areas may be affected. Fishes such as *Ictalurus catus, I. punctatus, Morone saxatilis,* and *Anguilla rostrata*, which are frequently encountered in lower salinity regions of estuaries, may increase in abundance in the Santee system; however, the effect on most species, such as the euryhaline sciaenid fishes which are numerically dominant in South Carolina estuaries (Shealy et al. 1974), cannot be predicted.

The present study examines quantitative annual and seasonal variability, diversity, and species assemblages of fishes and decapod Crustacea found in the channel of the lower North and South Santee Rivers. Our primary consideration is to describe the megafaunal community as it currently exists and to relate distributional patterns to abiotic factors which may influence the community after rediversion.

STUDY AREA

All sampling stations were located within the Santee River system (Fig. 1). The Santee River provides the major headwaters

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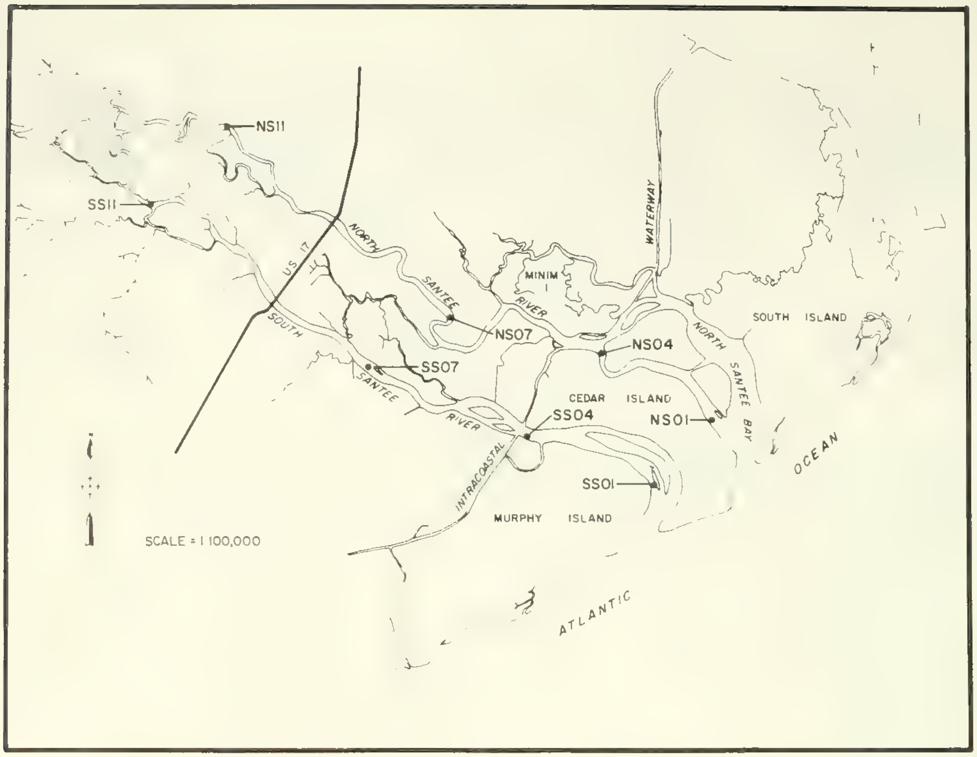

Figure 1.—Station locations in North and South Santee Rivers, S.C.

supplying Lakes Marion and Moultrie. About 23 km from the ocean, the Santee River bifurcates to form the North and South Santee Rivers.

The Santee system has been classified by Kjerfve and Greer (1978) as a partially mixed estuary with weak-to-moderate salinity stratification and gravitational circulation. However, this classification is variable due to tidal fluctuations as well as variations in saltwater intrusion and freshwater discharge (Cummings 1970[3]; Stephens et al. 1975; Kjerfve 1976; Nelson 1976; Burrell 1977; Calder et al. 1977). The South Santee River receives less freshwater drainage, with the result that saltwater intrusion is greater than in the North Santee River.

The two distributaries differ somewhat with regard to bathymetry since the North Santee River is slightly deeper than the South Santee River. Substrate in both rivers is very similar, being predominately coarse to fine-grained sand and shell of oceanic origin at the mouths, and hard mud and sand mix in the intermediate reaches of the estuary, replaced by fine-grained sand of inland origin in the upper estuary (Calder et al. 1977).

Dissolved oxygen values fluctuate seasonally, being usually 9-14 mg/liter in winter and ≥4 mg/liter in summer (Cummings footnote 3; Nelson 1976; Mathews[4]).

MATERIALS AND METHODS

Data Collection

We sampled eight stations which were located in the channel at 1, 4, 7, and 11 river miles from the mouths of the North and South Santee Rivers (Fig. 1). Hereafter, we will refer to these stations as NS01, NS04, NS07, and NS11 in the North Santee River and SS01, SS04, SS07, and SS11 in the South Santee River. Stations were sampled monthly over a 2-yr period from January 1975 through December 1976, with the following exceptions which were not included in our analysis: SS11 was not sampled in 1975; NS11 was sampled with a 5 m (16 ft) trawl in May and July 1975; and NS07 was not successfully trawled in May 1975.

All collections were made with a 6 m (12 ft) semiballoon otter trawl with 8 m headrope, composed of 2.5 cm (1 in) stretch mesh throughout. A complete description of the trawl is given by Shealy et al. (1974). Twenty-minute tows were made against floodtide during daylight hours at a speed of 1.3 m/s (2.5 kn), which resulted in a coverage of 1.5 ± 0.4 km during a tow.

Bottom-water samples were collected with 6 liter capacity Van Dorn bottles 0.3 m above the bottom at each station prior to trawling. Water temperature was read from stem thermometers mounted within the Van Dorn bottles. Salinity was measured in the laboratory with a Beckman RS7B induction salinometer. Dissolved oxygen was determined by the Winkler-Carpenter method (Strickland and Parsons 1968). Turbidity was determined with a Hach Model 2100A turbidimeter. Specimens were either processed in the field or preserved in 10% Formalin and returned to the laboratory for identification, measuring, and weighing. All specimens were weighed to the nearest 0.1 g and counted. We also recorded measurements (total length for fishes, carapace width for crabs, and total length for shrimps) for all species numbering ≤50 specimens per tow. At stations where the trawl caught larger numbers of organisms, we subsampled the catch as follows: If ≥50 to ≤250 individuals were collected, then a minimum of 50 randomly selected specimens were measured; if >250 to ≤500 individuals were caught, then

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[3] Cummings, T. R. 1970. A reconnaissance of the Santee River estuary, South Carolina. A report prepared by United States Geological Survey, Water Resources Division, Columbia, S.C., 96 p.

[4] T. Mathews, Assistant Marine Scientist, South Carolina Marine Resources Research Institute, Charleston, SC 29412, pers. commun. December 1979.

20% of the catch was measured; when >500 were caught, 10% of the catch was measured.

Data Analysis

Cluster analysis was used to define assemblages of fishes and decapod crustaceans and to determine degree of similarity among stations. Prior to cluster analysis, data were logarithmically transformed by $\log_{10}(x + 1)$, where x is number of individuals for a given species. We reduced data by elimination of species which occurred in fewer than three collections during a sampling period and by elimination of collections which contained only one species.

The methods of cluster analysis used are described in detail by Boesch (1977). The Bray-Curtis coefficient (Clifford and Stephenson 1975) was used to compute similarity values. Symmetrical similarity matrices were computed for both the North and South Santee Rivers on data from the 2-yr sampling period with collections as entities and species as attributes (normal analysis), and with species as entities and sites as attributes (inverse analysis). Entities were classified into related groups by using flexible sorting (Lance and Williams 1967) with $\beta = -0.25$.

Two separate dendrograms were generated for each river: A dendrogram which indicated association of all collections during the 2-yr sampling period based on their faunal content and a dendrogram which indicated association of all species from the collections made during the 2-yr sampling period. We used postclustering techniques of nodal analysis (Williams and Lambert 1961; Lambert and Williams 1962) to examine species and station coincidences. Nodal analysis diagrams were made by using patterns of constancy (a measure of how consistently a species is found in a site group) and fidelity (a measure of how restricted a species is to a site group).

An index of abundance (Musick and McEachran 1972; Elliott 1977) was used to compare numbers and weights of selected dominant species and is expressed as:

$$\text{Index of Abundance} = \frac{1}{n}\sum_{l}^{n} \log_{10}(x + 1),$$

where x = number or weight of individuals of a given species and n = number of collections in a chosen time frame.

We determined biomass and density estimates for fishes and decapods from computations of area swept for trawl gears. Estimates of area swept (a) were determined by the following equation given by Roe (1969):

$$a = \frac{K \times M \times (0.6\,H)}{10{,}000 \text{ m}^2/\text{ha}},$$

where K is speed in meters per hour, M is time in hours fished, and H is headrope length in meters (Klima[5]). Roe (1969) assumed an effective swath of about 60% of the headrope length as established by Wathne (1959). The area swept by our 6 m otter trawl was estimated to be 0.72 ha/tow based on the method described by Roe (1969).

RESULTS

Hydrographic Parameters

Bottomwater temperatures were very similar between rivers and among stations. Temperatures were lowest in both the North and South Santee Rivers during February and March 1975 and January and February 1976. In the North Santee River, temperatures gradually increased from April to reach a peak in either August (1976) or September (1975). The warmest month in the South Santee River during both years of sampling was August. Based on temperature over the 2-yr sampling period, winter encompassed January, February, and March; spring, April, May, and June; summer, July, August, and September; and fall, October, November, and December.

Salinities were extremely variable both seasonally and among stations. Freshwater outflow increased in the Santee watershed from 14.2 m^3/s to an average of 679.3 m^3/s between mid-March and mid-April 1975 and to 238.5 m^3/s from mid-May until late June 1975 (Burrell 1977). These freshets considerably lowered salinities at stations in both rivers. Salinities were also variable in 1976 but the extreme fluctuations caused by freshwater outflow were not as evident as in 1975. Except during periods of high runoff when freshwater was found throughout the system, salinity decreased from stations located at the river mouth to those located upstream. Salinities at stations SS01 and NS01 ranged from 0.2 to 32.9‰, which characterized these stations as limnetic-euhaline by the Venice System (Symposium on the Classification of Brackish Waters 1958). Stations SS04 and NS04 were limnetic-polyhaline (0.1-26‰), while SS07 and NS07 were limnetic-mesohaline (0.1-15.9‰). Salinities at NS11 and SS11 ranged from <0.1 to 1.4‰ and were within the limnetic-oligohaline salinity regime.

Community Composition and Diversity

Eighty species of fishes were collected from the South Santee River and 64 species from the North Santee River during the 1975-76 sampling period (Table 1). Eleven species accounted for 93% of the total number of specimens and 70% of the total fish biomass taken in both rivers: Atlantic croaker, *Micropogonias undulatus*; bay anchovy, *Anchoa mitchilli*; silver perch, *Bairdiella chrysoura*; star drum, *Stellifer lanceolatus*; white catfish, *Ictalurus catus*; weakfish, *Cynoscion regalis*; threadfin shad, *Dorosoma petenense*; spot, *Leiostomus xanthurus*; hogchocker, *Trinectes maculatus*; Atlantic menhaden, *Brevoortia tyrannus*; and blackcheek tonguefish, *Symphurus plagiusa*. In both rivers, *M. undulatus* was the most abundant species collected. With regard to biomass, however, *M. undulatus* was outranked by *I. catus* in the North Santee River and *Bairdiella chrysoura* in the South Santee River.

The decapod crustaceans were represented by 22 species in the North Santee River and 18 species in the South Santee River. Although fewer species of decapods than fish were collected, the decapods dominated in terms of total number of individuals captured (Table 2). The numerical dominance of the decapods was due to extremely large catches of the white shrimp, *Penaeus setiferus*, especially in the South Santee River. This species was by far the most abundant decapod collected in both rivers and also dominated other decapods in terms of biomass. *Penaeus setiferus*, together with the brown shrimp, *P. aztecus*, and the blue crab, *Callinectes sapidus*, comprised over 96% by number and weight of the total decapod fauna collected in both rivers.

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[5] Klima, E. F. 1976. A review of the fishery resources in the western central Atlantic. West. Cent. Atl. Fish. Comm. Publ. 3, 77 p.

Table 1.—Total number and total weight (kg) of fishes collected from 1975 and 1976 in estuaries of the North and South Santee Rivers, S.C. Species are listed in order of abundance, and data are pooled for the 2-yr sampling period.

Species	Total no.	Percent of total catch	Total weight	Percent weight
North Santee River:				
Micropogonias undulatus	3,535	23.68	20.282	10.12
Trinectes maculatus	3,233	21.66	15.251	7.61
Ictalurus catus	1,975	13.23	58.429	29.16
Anchoa mitchilli	1,502	10.06	2.895	1.44
Brevoortia tyrannus	824	5.52	13.600	6.79
Stellifer lanceolatus	766	5.13	3.651	1.82
Cynoscion regalis	555	3.72	2.528	1.26
Bairdiella chrysoura	531	3.56	8.621	4.30
Dorosoma petenense	467	3.13	1.831	0.91
Symphurus plagiusa	418	2.80	5.387	2.69
Leiostomus xanthurus	207	1.39	9.135	4.56
Ictalurus punctatus	150	1.00	3.623	1.81
Ictalurus furcatus	142	0.95	7.785	3.88
Paralichthys lethostigma	131	0.88	15.664	7.82
Menticirrhus americanus	57	0.38	0.531	0.26
Urophycis regia	50	0.33	0.339	0.17
Arius felis	49	0.33	1.024	0.51
Opsanus tau	29	0.19	1.502	0.75
Paralichthys dentatus	25	0.17	0.840	0.42
Etropus crossotus	25	0.17	0.075	0.04
Anguilla rostrata	19	0.13	2.301	1.15
Alosa sapidissima	17	0.11	0.114	0.06
Urophycis floridana	17	0.11	0.582	0.29
Cyprinus carpio	16	0.11	2.793	1.39
Cynoscion nebulosus	13	0.09	0.327	0.16
Chloroscombrus chrysurus	13	0.09	0.028	0.01
Alosa aestivalis	12	0.08	0.295	0.15
Dasyatis sabina	12	0.08	10.851	5.41
Gobiesox strumosus	11	0.07	0.047	0.02
Prionotus tribulus	11	0.07	0.022	0.01
Peprilus triacanthus	9	0.06	0.045	0.02
Pomatomus saltatrix	9	0.06	0.220	0.11
Morone saxatilis	8	0.05	0.070	0.03
Peprilus alepidotus	8	0.05	0.045	0.02
Astroscopus y-graecum	7	0.05	0.067	0.03
Anchoa hepsetus	7	0.05	0.055	0.03
Hypsoblennius hentzi	6	0.04	0.045	0.02
Centropristis striata	6	0.04	0.228	0.11
Lagodon rhomboides	6	0.04	0.044	0.02
Mugil cephalus	5	0.03	0.199	0.10
Ictalurus platycephalus	5	0.03	0.717	0.36
Ancylopsetta quadrocellata	4	0.03	0.037	0.02
Dorosoma cepedianum	4	0.03	1.243	0.62
Ophidion marginatum	4	0.03	0.149	0.07
Lepisosteus osseus	3	0.02	5.213	2.60
Selene vomer	3	0.02	0.013	0.01
Membras martinica	2	0.01	0.005	<0.01
Eucinostomus argenteus	2	0.01	0.021	0.01
Citharichthys spilopterus	2	0.01	0.005	<0.01
Gobionellus hastatus	2	0.01	0.093	0.05
Hypsoblennius ionthas	2	0.01	0.007	<0.01
Chaetodipterus faber	1	0.01	0.223	0.11
Prionotus scitulus	1	0.01	0.002	<0.01
Archosargus probatocephalus	1	0.01	0.338	0.17
Morone americana	1	0.01	0.484	0.24
Centropristis philadelphica	1	0.01	0.144	0.07
Bagre marinus	1	0.01	0.007	<0.01
Acipenser oxyrhynchus	1	0.01	0.300	0.15
Prionotus sp.	1	0.01	0.001	<0.01
Gobionellus shufeldti	1	0.01	0.001	<0.01
Eucinostomus sp.	1	0.01	0.008	<0.01
Scophthalmus aquosus	1	0.01	0.002	<0.01
Perca flavescens	1	0.01	0.017	0.01
Chilomycterus schoepfi	1	0.01	0.002	<0.01
Total	14,929		200.403	
South Santee River:				
Micropogonias undulatus	4,385	31.72	23.815	13.90
Anchoa mitchilli	2,944	21.29	4.259	2.49
Bairdiella chrysoura	2,187	15.82	33.547	19.58
Stellifer lanceolatus	636	4.60	3.419	2.00
Ictalurus catus	625	4.52	25.443	14.85
Cynoscion regalis	595	4.30	2.478	1.45
Dorosoma petenense	400	2.89	2.102	1.23
Leiostomus xanthurus	348	2.52	9.100	5.31
Trinectes maculatus	304	2.20	1.657	0.97
Brevoortia tyrannus	291	2.10	11.039	6.44
Symphurus plagiusa	220	1.59	2.193	1.28
Paralichthys lethostigma	155	1.12	13.274	7.75
Opsanus tau	85	0.61	7 470	4.36
Hypsoblennius ionthas	60	0.43	0.187	0.11
Hypsoblennius hentzi	58	0.42	0.246	0.14
Paralichthys dentatus	42	0.30	1.502	0.88
Menticirrhus americanus	34	0.25	0.284	0.17
Cynoscion nebulosus	30	0.22	1.033	0.60
Centropristis striata	29	0.21	0.627	0.37
Urophycis regia	28	0.20	0.351	0.20
Peprilus triacanthus	26	0.19	0.203	0.12
Gobiesox strumosus	25	0.18	0.076	0.04
Peprilus alepidotus	23	0.17	0.130	0.08
Chloroscombrus chrysurus	21	0.15	0.196	0.11
Alosa aestivalis	20	0.14	0.057	0.03
Alosa sapidissima	19	0.14	0.149	0.09
Etropus crossotus	19	0.14	0.206	0.12
Citharichthys spilopterus	18	0.13	0.118	0.07
Ictalurus furcatus	17	0.12	0.632	0.37
Archosargus probatocephalus	17	0.12	3.861	2.25
Urophycis floridana	16	0.12	0.432	0.25
Lagodon rhomboides	13	0.09	0.405	0.24
Dasyatis sabina	9	0.07	7.515	4.39
Lepisosteus osseus	8	0.06	8.075	4.71
Pomatomus saltatrix	8	0.06	0.285	0.17
Prionotus tribulus	8	0.06	0.011	0.01
Selene vomer	7	0.05	0.046	0.03
Anchoa hepsetus	7	0.05	0.057	0.03
Ancylopsetta quadrocellata	6	0.04	0.382	0.22
Prionotus evolans	6	0.04	0.009	0.01
Ictalurus punctatus	6	0.04	0.227	0.13
Opisthonema oglinum	5	0.04	0.014	0.1
Caranx hippos	4	0.03	0.008	<0.01
Centropristis philadelphica	4	0.03	0.172	0.10
Ophidion marginatum	4	0.03	0.166	0.10
Lutjanus griseus	4	0.03	0.041	0.02
Morone saxatilis	3	0.02	0.054	0.03
Dorosoma cepedianum	3	0.02	0.143	0.08
Arius felis	3	0.02	0.418	0.24
Eucinostomus sp.	3	0.02	0.042	0.02
Prionotus scitulus	3	0.02	0.007	<0.01
Scomberomorus maculatus	2	0.01	0.043	0.03
Eleotris pisonis	2	0.01	0.024	0.01
Astroscopus y-graecum	2	0.01	0.011	0.01
Bagre marinus	2	0.01	0.158	0.09
Orthopristis chrysoptera	2	0.01	0.112	0.07
Chaetodipterus faber	2	0.01	0.176	0.10
Mugil cephalus	1	0.01	0.100	0.06
Sciaenops ocellata	1	0.01	0.002	<0.01
Larimus fasciatus	1	0.01	0.001	<0.01
Eucinostomus argenteus	1	0.01	0.002	<0.01
Morone americana	1	0.01	0.338	0.20
Syngnathus louisianae	1	0.01	0.008	<0.01
Menidia menidia	1	0.01	0.002	<0.01
Membras martinica	1	0.01	0.004	<0.01
Strongylura marina	1	0.01	0.075	0.04
Trachinotus falcatus	1	0.01	0.004	<0.01
Trachinotus carolinus	1	0.01	0.005	<0.01
Urophycis earlli	1	0.01	0.001	<0.01
Brevoortia smithi	1	0.01	0.268	0.16

Table 1.—*Continued.*

Species	Total no.	Percent of total catch	Total weight	Percent weight
South Santee River.—*Cont.*				
Anguilla rostrata	1	0.01	0.150	0.09
Mugil curema	1	0.01	0.040	0.02
Gobionellus hastatus	1	0.01	0.009	0.01
Prionotus carolinus	1	0.01	0.001	<0.01
Prionotus sp.	1	0.01	0.002	<0.01
Cyprinus carpio	1	0.01	1.562	0.91
Gobionellus shufeldti	1	0.01	0.002	<0.01
Diapterus olisthostomus	1	0.01	0.022	0.01
Chilomycterus schoepfi	1	0.01	0.085	0.05
Monacanthus hispidus	1	0.01	0.003	<0.01
Total	13,826		171.372	

The total number of species of fishes and decapods varied over the 2-yr sampling period with the greatest number occurring in summer in both rivers (Fig. 2). Fewest species were collected during spring of 1975 when freshwater input and riverflow drastically increased. The dramatic drop in number of species was most noticeable at stations located upriver (NS07, NS11, and SS07). The total number of species captured was much lower during this time period than in spring of 1976 when no freshet occurred. During the 2-yr sampling period, more species were collected at stations nearest the mouths of both rivers.

The number of individual fish and decapod crustaceans, expressed in logarithms, showed patterns similar to the number of species when plotted over time (Fig. 2). In both rivers, numbers of individuals were greater during 1975, with peaks occurring in summer.

The number of species and number of individuals were compared to environmental factors such as bottom temperature, salinity, oxygen, turbidity, and depth using Pearson's product-moment correlation coefficient (Table 3). Based on these analyses, we found the number of species in the North Santee River to be significantly associated with bottom temperature and salinity in 1975 and with salinity and depth in 1976. In the South Santee River, the number of species was significantly associated with salinity during both years.

In the North Santee system, the number of individuals was positively correlated with bottom temperature in 1975, but there were no significant associations detected between number of individuals and environmental factors in 1976 (Table 3). The number of individuals captured in the South Santee system was positively correlated with bottom temperature and negatively correlated with oxygen in 1975 and 1976. A positive correlation with depth was found also in 1976.

Normal cluster analysis revealed that no strong differentiation of collections existed by river mile. Rather, collections made in the limnetic-euhaline zone were grouped with those from the limnetic-oligohaline zone indicating little stratification of the fauna according to salinity regime. In addition, an examination of the allocation of collections according to station and month indicated that association of the collections was not related to time of year. Based on similarity of faunal composition, we discerned three primary station groups by cluster analysis of data from the North Santee River: 1) a group in which collections at station NS01, NS04, and NS07 were represented by nearly equal numbers of collections; 2) a group in which collections at station NS01 predominated; and 3) a group which was most distinct from the other groups and was dominated by collections made at station NS11. Two major groupings of stations were indicated by cluster analysis for the South Santee River: 1) a group consisting mostly of collections from stations SS01 and SS04, and 2) a group consisting predominantly of collections from stations SS07 and SS11.

Table 2.—Total number and total weight (kg) of decapod Crustacea collected from 1975 and 1976 in the North and South Santee Rivers. Species are listed in order of abundance and data are pooled over the 2-yr sampling period.

Species	Total no.	Percent of total catch	Total weight	Percent weight
North Santee River:				
Penaeus setiferus	34,998	90.08	121.703	48.38
Penaeus aztecus	1,556	4.00	13.393	5.32
Callinectes sapidus	1,318	3.39	114.709	45.60
Palaemonetes vulgaris	510	1.31	0.228	0.09
Palaemonetes pugio	255	0.66	0.125	0.05
Penaeus duorarum	95	0.24	1.036	0.41
Panopeus herbstii	23	0.06	0.085	0.03
Portunus gibbesii	19	0.05	0.016	0.01
Callinectes similis	18	0.05	0.161	0.06
Trachypenaeus constrictus	18	0.05	0.019	0.01
Rhithropanopeus harrisii	17	0.04	0.013	0.01
Clibanarius vittatus	13	0.03	0.024	0.01
Portunus spinimanus	5	0.01	0.008	<0.01
Macrobrachium ohione	3	0.01	0.028	0.01
Xiphopenaeus kroyeri	2	0.01	0.004	<0.01
Panopeus occidentalis	2	0.01	0.002	<0.01
Panopeus sp.	1	<0.01	0.001	<0.01
Alpheus heterochaelis	1	<0.01	0.001	<0.01
Total	38,854		251.556	
South Santee River:				
Penaeus setiferus	10,431	78.80	44.333	44.98
Penaeus aztecus	1,726	13.04	10.242	10.39
Callinectes sapidus	568	4.29	42.763	43.39
Macrobrachium ohione	120	0.91	0.414	0.42
Palaemonetes pugio	90	0.68	0.047	0.05
Palaemonetes vulgaris	89	0.67	0.052	0.05
Trachypenaeus constrictus	83	0.63	0.071	0.07
Callinectes similis	31	0.23	0.184	0.19
Penaeus duorarum	17	0.13	0.077	0.08
Clibanarius vittatus	16	0.12	0.024	0.02
Pagurus longicarpus	12	0.09	0.006	0.01
Xiphopenaeus kroyeri	12	0.09	0.030	0.03
Rhithropanopeus harrisii	10	0.08	0.134	0.14
Portunus spinimanus	7	0.05	0.104	0.11
Callinectes similis or *ornatus*[1]	7	0.05	0.018	0.02
Callinectes ornatus	5	0.04	0.031	0.03
Panopeus herbstii	4	0.03	0.006	0.01
Portunus gibbesii	3	0.02	0.007	0.01
Alpheus heterochaelis	2	0.02	0.002	<0.01
Acetes americanus	1	0.01	0.001	<0.01
Ovalipes ocellatus	1	0.01	0.002	<0.01
Eurypanopeus depressus	1	0.01	0.001	<0.01
Xanthidae[2]	1	0.01	0.008	0.01
Total	13,237		98.557	

Field identification.

[2] Specimen damaged and unidentifiable, not included in analyses.

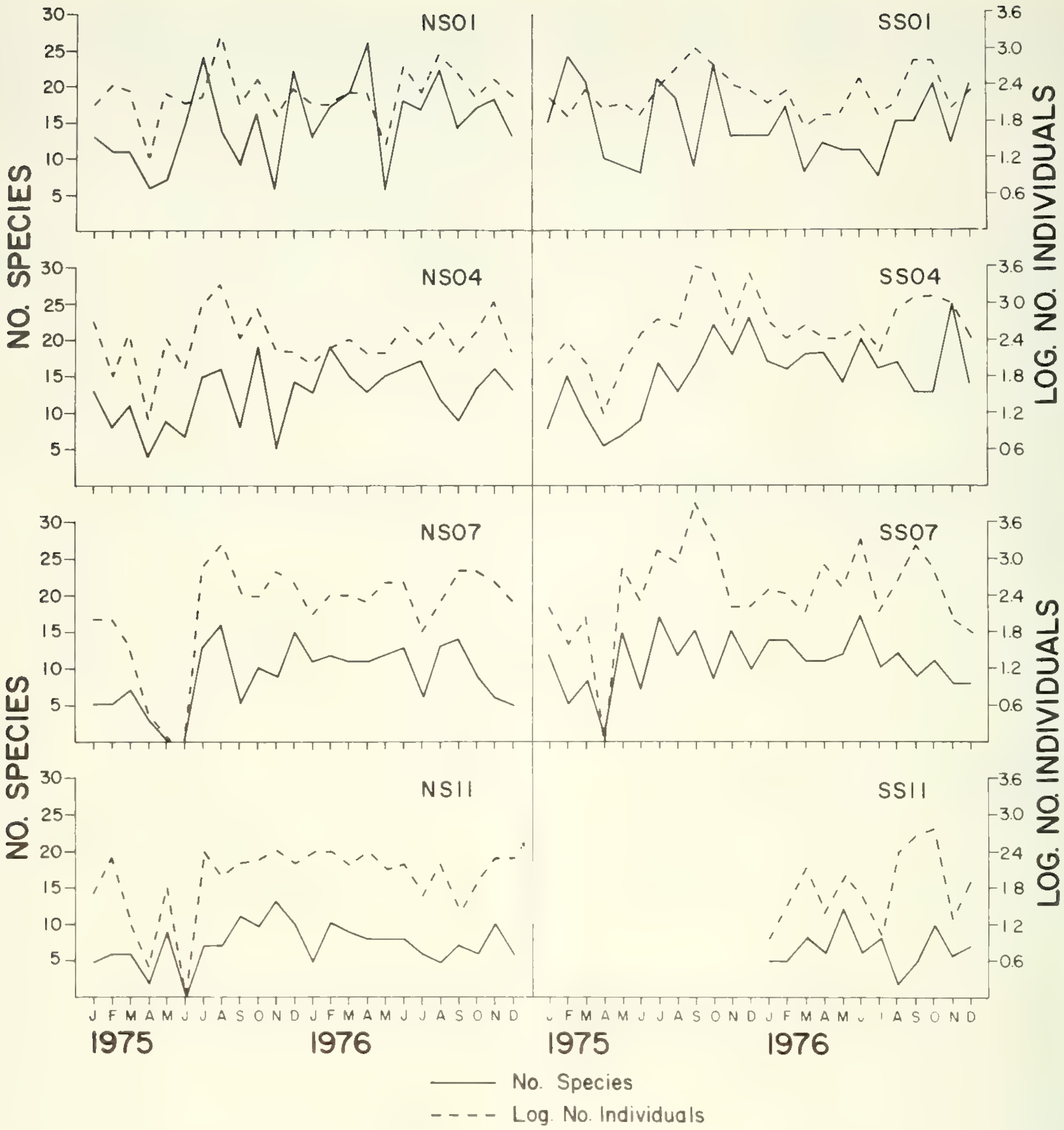

Figure 2.—Monthly fluctuations in number of species and number of individuals (log transformed) of fishes and decapod crustaceans at sampling sites in the North and South Santee Rivers, 1975-76.

Table 3.—Correlation between ln (n + 1) transformed values of number of species and number of individuals of fishes and decapods in relation to environmental factors. r = Pearson product-moment correlation coefficient; n = number of observations.

	1975				1976			
	North Santee		South Santee		North Santee		South Santee	
Environmental factor	r	n	r	n	r	n	r	n
	Number of species				Number of species			
Bottom temperature (°C)	0.4270*	45	0.1646	36	−0.0225	48	−0.0769	48
Salinity (‰)	0.3984*	45	0.4185*	36	0.5437*	48	0.5929*	48
Oxygen (mg/liter)	−0.1575	45	−0.0457	36	−0.0110	48	0.0074	48
Turbidity (FTU)**	0.2972	45	0.0849	36	−0.0550	48	−0.2213	48
Depth (m)	−0.3045	45	0.0170	36	−0.6029*	48	0.2420	48
	Number of individuals				Number of individuals			
Bottom temperature (°C)	0.5003*	45	0.5158*	36	0.0239	48	0.3385*	48
Salinity (‰)	0.2006	45	0.1605	36	0.0187	48	0.2766	48
Oxygen (mg/liter)	−0.0768	45	−0.3710*	36	−0.0614	48	−0.3089*	48
Turbidity (FTU)	0.1575	45	−0.2985	36	0.0142	48	−0.0146	48
Depth (m)	−0.1624	45	−0.1052	36	−0.1766	48	0.4652*	48

*Significant ($\rho \neq 0$) at α = 0.05.

**FTU = Formazin Turbidity Units.

Table 4.—Groups formed from cluster analysis of species of fishes and decapod Crustacea collected in the North and South Santee Rivers from 1975 and 1976. Dendrograms are not shown.

North Santee R.	South Santee R.
Group A *Lagodon rhomboides* *Alpheus heterochaelis* *Eucinostomus argenteus*	Group A *Ophidion marginatum* *Ancylopsetta quadrocellata* *Urophycis regia* *Urophycis floridana* *Etropus crossotus* *Alosa sapidissima* *Cynoscion nebulosus* *Archosargus probatocephalus* *Lutjanus griseus* *Lagodon rhomboides*
Group B *Prionotus tribulus* *Dasyatis sabina* *Callinectes similis* *Gobiesox strumosus* *Etropus crossotus* *Hypsoblennius hentzi* *Xiphopenaeus kroyeri*	Group B *Dasyatis sabina* *Citharichthys spilopterus* *Caranx hippos* *Eucinostomus* sp. *Centropristis philadelphica*
Group C *Astroscopus y-graecum* *Ancylopsetta quadrocellata* *Ophidion marginatum* *Urophycis floridana* *Centropristis striata* *Urophycis regia* *Penaeus duorarum*	Group C *Hypsoblennius ionthas* *Trachypenaeus constrictus* *Menticirrhus americanus* *Clibanarius vittatus* *Hypsoblennius hentzi* *Penaeus duorarum* *Centropristis striata* *Opsanus tau* *Symphurus plagiusa* *Gobiesox strumosus* *Paralichthys dentatus*
Group D *Arius felis* *Peprilus alepidotus* *Callinectes ornatus* *Selene vomer* *Portunus gibbesii* *Pagurus longicarpus* *Clibanarius vittatus* *Opsanus tau* *Trachypenaeus constrictus* *Menticirrhus americanus*	Group D *Pomatomus saltatrix* *Peprilus triacanthus* *Anchoa hepsetus* *Chloroscombrus chrysurus* *Panopeus herbstii*
Group E *Alosa sapidissima* *Paralichthys dentatus* *Cynoscion nebulosus* *Mugil cephalus* *Dorosoma petenense* *Gobionellus hastatus* *Rhithropanopeus harrisii* *Peprilus triacanthus* *Anchoa hepsetus* *Panopeus herbstii* *Pomatomus saltatrix* *Chloroscombrus chrysurus*	Group E *Cynoscion regalis* *Penaeus aztecus* *Stellifer lanceolatus* *Callinectes similis* *Peprilus alepidotus* *Selene vomer* *Lepisosteus osseus* *Rhithropanopeus harrisii* *Macrobrachium ohione*
Group F *Lepisosteus osseus* *Cyprinus carpio* *Palaemonetes pugio* *Alosa aestivalis* *Ictalurus punctatus* *Ictalurus furcatus* *Macrobrachium ohione* *Anguilla rostrata* *Morone saxatilis*	Group F *Ictalurus punctatus* *Ictalurus furcatus* *Alosa aestivalis*
Group G *Ictalurus catus* *Trinectes maculatus* *Micropogonias undulatus* *Anchoa mitchilli* *Penaeus setiferus* *Bairdiella chrysoura* *Cynoscion regalis* *Stellifer lanceolatus* *Penaeus aztecus* *Symphurus plagiusa* *Callinectes sapidus* *Paralichthys lethostigma* *Brevoortia tyrannus* *Leiostomus xanthurus* *Palaemonetes vulgaris*	Group G *Anchoa mitchilli* *Bairdiella chrysoura* *Callinectes sapidus* *Penaeus setiferus* *Paralichthys lethostigma* *Brevoortia tyrannus* *Leiostomus xanthurus* *Micropogonias undulatus* *Trinectes maculatus* *Ictalurus catus* *Palaemonetes vulgaris* *Palaemonetes pugio* *Dorosoma petenense*

The classification based on the quantitative similarities of distribution of species found in the North and South Santee Rivers produced the species groups shown in Table 4. In order to determine affinity of species assemblages along the estuarine gradient, we compared species group constancy and fidelity among the eight stations occupied in the North and South Santee Rivers during 1975 and 1976 (Fig. 3). This was deemed preferable to comparing site groups determined by cluster analysis with species groups because site groups broadly overlapped and were not clearly separated by cluster analysis according to salinity regimes within the estuary.

In the North Santee River, one species group (G) was consistently encountered at stations NS01 and NS04, with slight decline in constancy at NS07 and NS11 (Fig. 3). Species in this group were not restricted in their distribution to any station location but were ubiquitous over the sites sampled, which is an indication of their apparent euryhalinity. The other species groups were not consistently collected at any of the stations, as indicated by low constancy. Species group B, which is largely composed of coastal marine fishes, was entirely restricted to station NS01, which suggests the stenohaline nature and transient occurrences of these fishes within the estuary. Other groups (A and D) were also apparently composed of marine species which were not able to penetrate far into the estuary. Group E species were associated with intermediate to higher salinities and did not

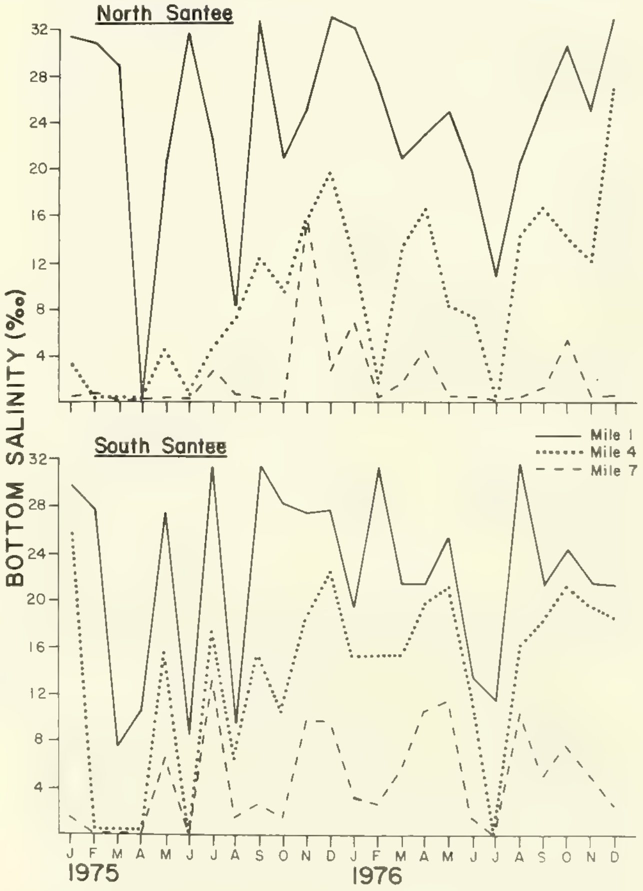

Figure 3.—Two-way coincidence tables of constancy and fidelity which compare species associations with stations in the North and South Santee Rivers, 1975-76. The species associations, designated alphabetically, resulted from cluster analysis of species (dendrogram not shown) collected from the Santee system. Species comprising these associations are listed in Table 5.

occur at stations upriver from NS04. Members of group F were not found downestuary of station NS07.

In the South Santee River, species in group G were considered to be ubiquitous over all sites. The constancy of these species ranged from high at stations SS04 and SS07 to moderate at SS01 and SS11; however, species in this group were not restricted to any station location. Groups A, C, and D included species which were associated with higher salinity areas in proximity to the river mouth. Stenohaline marine species in these groups included sheepshead, *Archosargus probatocephalus*; black sea bass, *Centropristis striata*, butterfish, *Peprilus triacanthus*; and Atlantic bumper, *Chloroscombrus chrysurus*. Group B species were not consistently collected at any station location and displayed low fidelity to stations SS04 and SS11. These species are generally considered to be marine in origin and their penetration as far as SS11 is unusual. Species which were associated with higher and intermediate salinities constituted group E. These were found at all stations except SS11, but were not consistently collected at any site. Group F contained the stenohaline freshwater species, *Ictalurus punctatus* and *I. furcatus*, and the anadromous species, blueback herring, *Alosa aestivalis*, which were restricted to station SS11.

Based on results of the two-way coincidence table (Fig. 3), it was possible to distinguish four assemblages of fishes and decapod Crustacea in both the North and South Santee Rivers. The first assemblage consisted of euryhaline species which occurred throughout both rivers and included the fishes *Anchoa mitchilli*; *Brevoortia tyrannus*; *Trinectes maculatus*; *Micropogonias undulatus*; *Leiostomus xanthurus*; *Bairdiella chrysoura*; southern flounder, *Paralichthys lethostigma*; and *I. catus*; and the decapods *Penaeus setiferus, Callinectes sapidus,* and *Palaemonetes vulgaris*, grass shrimp. Coastal marine species, which may penetrate into the estuary for short periods of time, constituted the second assemblage. Species in this category included the fishes *Centropristis striata*; skilletfish, *Gobiesox strumosus*; feather blenny, *Hypsoblennius hentzi*; southern kingfish, *Menticirrhus americanus*; and pinfish, *Lagodon rhombiodes*—and the decapods pink shrimp, *Penaeus duorarum*, and humpback shrimp, *Trachypenaeus constrictus*. The third assemblage consisted of species which can tolerate a range of intermediate to low salinities. *Rhithropanopeus harrisii*, mud crab, which occurs in both the North and South Santee Rivers, was distributed in this manner. The fourth assemblage was composed of the stenohaline freshwater species *Ictalurus punctatus, I. furcatus*, and the anadromous species, *Alosa aestivalis*.

Although the formation of these categories is based on distributional patterns formed from an actual collection of the organisms, it remains an artificial attempt at forcing species into designated groups based on their general affinities within the estuary. Therefore, it is possible and certainly probable that species will encounter others outside their group and may even form peripheral associations. This is especially true of the euryhaline species which are capable of widespread penetration of the estuarine environment.

Temporal and Spatial Distributions—Fishes

Temporal and spatial distributions for four abundant species of fishes—*Micropogonias undulatus, Anchoa mitchilli, Ictalurus catus, Bairdiella chrysoura*, and *Trinectes maculatus*—are compared in Figures 4-6. A summary table of the distribution and lengths for all species collected is available from the authors.

Micropogonias undulatus, **Atlantic croaker.**—The Atlantic croaker was found throughout both rivers, although its presence at stations varied over the 2-yr sampling period (Fig. 4A). In the North Santee River, number and biomass of the Atlantic croaker were greatest during spring 1976 at NS07. This is in marked contrast to spring 1975 when none were collected at this station or at NS11 further upriver. The absence of croaker at these stations in 1975 may be attributed to the significant alteration of physicochemical properties by the freshet in spring 1975. A similar decrease in abundance was not noted in the South Santee River, but failure to occupy SS11 during 1975 precludes a true assessment of freshet effects far upriver. The apparent absence of Atlantic croaker at upriver stations in the North Santee River during fall 1976 cannot be readily attributed to any hydrographic parameter but may reflect a lag in recruitment of young fish during this period.

Length-frequency distributions (not shown) indicated that sizes of most Atlantic croaker available to our bottom trawls were <10 cm in both rivers during all seasons. The predominance of smaller fish accounts for the low biomass observed for Atlantic croaker. Young fish, 4-16 cm, were prevalent in both rivers during fall and winter. A few larger fish which ranged from 12 to 26 cm were also present, but their numbers were low, which could reflect gear avoidance, movement away from the channel, or emigration from the estuary. Size of young Atlantic croaker had increased to a mode of 8-9 cm by summer and abundance had increased. Others (Haven 1957; Hansen 1969; Hoese 1973; Shealy et al. 1974; Chao and Musick 1977) have noted that small Atlantic croakers are present in different estuarine systems along the east coast throughout much of the year. The abundance of young fish in the Santee system is probably related to the long spawning season of the Atlantic croaker (Chao and Musick 1977), which may be more protracted in South Carolina waters than in temperate northern estuaries, although our choice of sampling gear, biased toward capture of smaller fish, is undoubtedly also a factor.

Anchoa mitchilli, **the bay anchovy.**—*Anchoa mitchilli* was found at all stations in both the North and South Santee Rivers sometime during the 2-yr sampling period, but catches were generally greater in the South Santee River (Fig. 4). Abundance of *A. mitchilli* appeared to be lowest at low-salinity stations located further upriver in both rivers. This decreased abundance was especially noticeable in spring and summer. During these seasons, bay anchovy were found at more seaward stations within the estuary. This distributional pattern is similar to that observed in the Edisto and Cooper Rivers, S.C. (Shealy et al. 1974), and York River, Va. (Markle 1976).

Length-frequency distributions for *A. mitchilli* were strongly bimodal with smaller (20-35 mm) and larger (50-75 mm) fish cooccurring during most seasons (not shown). These data do not indicate an influx of small fish into the population during a particular season, such as summer (Hoese 1973; Shealy et al. 1974), but suggest that small fish are present in the Santee system throughout the year. Multiple spawns (Hoese 1965) or a protracted spawning season (Hildebrand and Cable 1930) best explain the bimodality of frequencies observed for bay anchovy in the Santee system. Similar findings were noted by Hoese (1965), who believed that *A. mitchilli* spawns during all seasons in Texas and probably is short-lived. In addition, Mansueti and

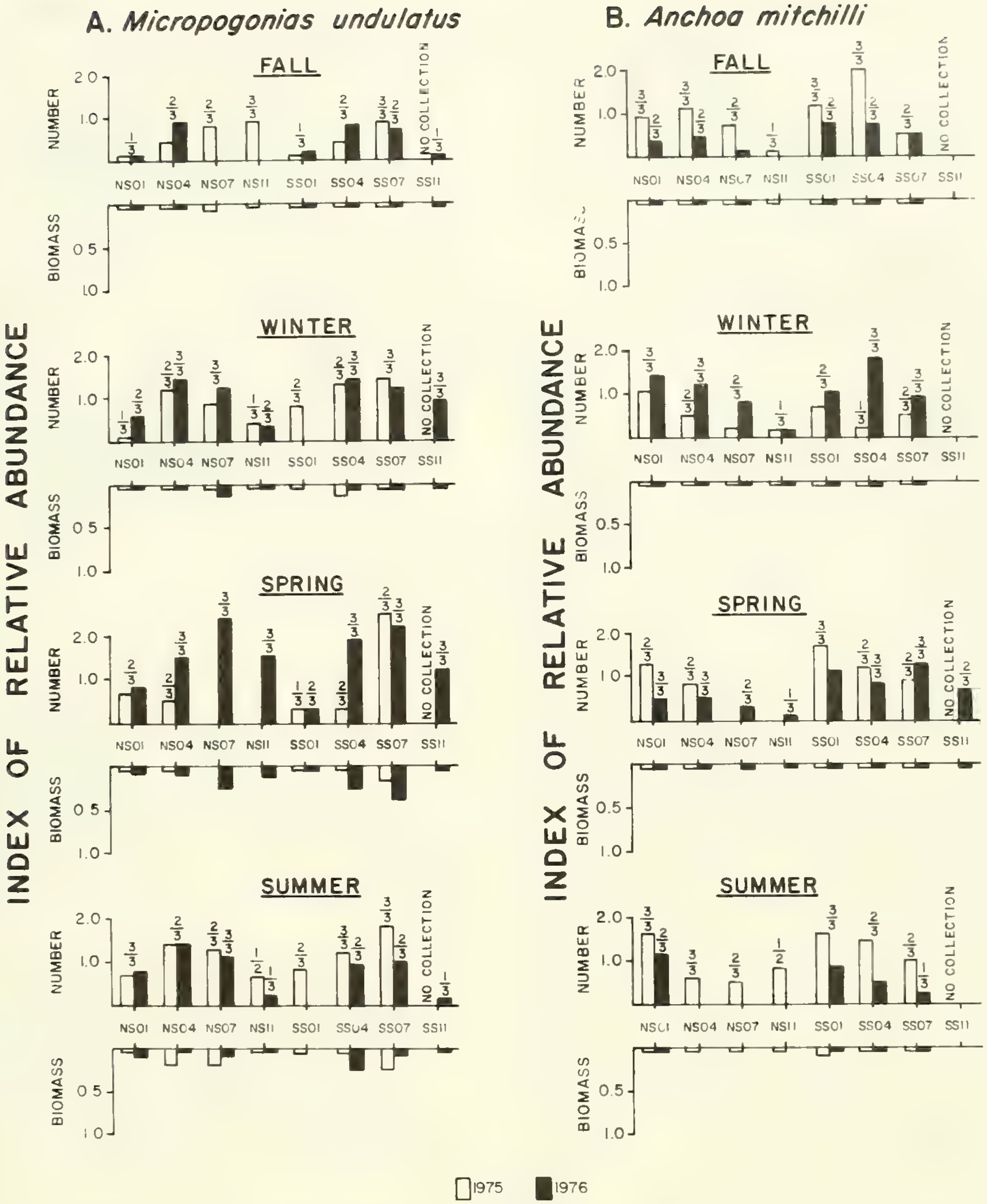

Figure 4.—Abundance of A) *Micropogonias undulatus* and B) *Anchoa mitchilli* by station and season for the North and South Santee Rivers. Ratios over bars indicate number of collections where fishes were captured to total number of collections at a station.

Hardy (1967) found sexually mature individuals at 2.5 mo of age in the Chesapeake Bay system.

Ictalurus catus, **white catfish.**—The distribution of *I. catus* was obviously influenced by salinity since catches declined markedly at higher salinity stations (Fig. 5A). In the North Santee River, catches of *I. catus* were greatest during all seasons at stations furthest upriver. Distributional patterns in the South Santee River were similar in that *I. catus* seldom occurred at higher salinity stations. Shealy et al. (1974) found no *I. catus* at estuary mouths of the North and South Edisto or Charleston Harbor-Cooper Rivers. The infrequent occurrence of white catfish at the mouth of the Santee River probably reflects the often low-salinity nature of the Santee River and the subsequent penetration by lower salinity species. High biomass of *I. catus* corresponded with peak numerical abundance in both rivers. Length-frequency distributions (not shown) showed that most white catfish collected in the Santee system were <100 mm, although the length range extended from 10 to 370 mm. Based on an age-growth study of *I. catus* from South Carolina (Stevens 1959), the fishes <100 mm are not older than 2 yr. In the North Santee River, young-of-the-year fish (<50 mm) were

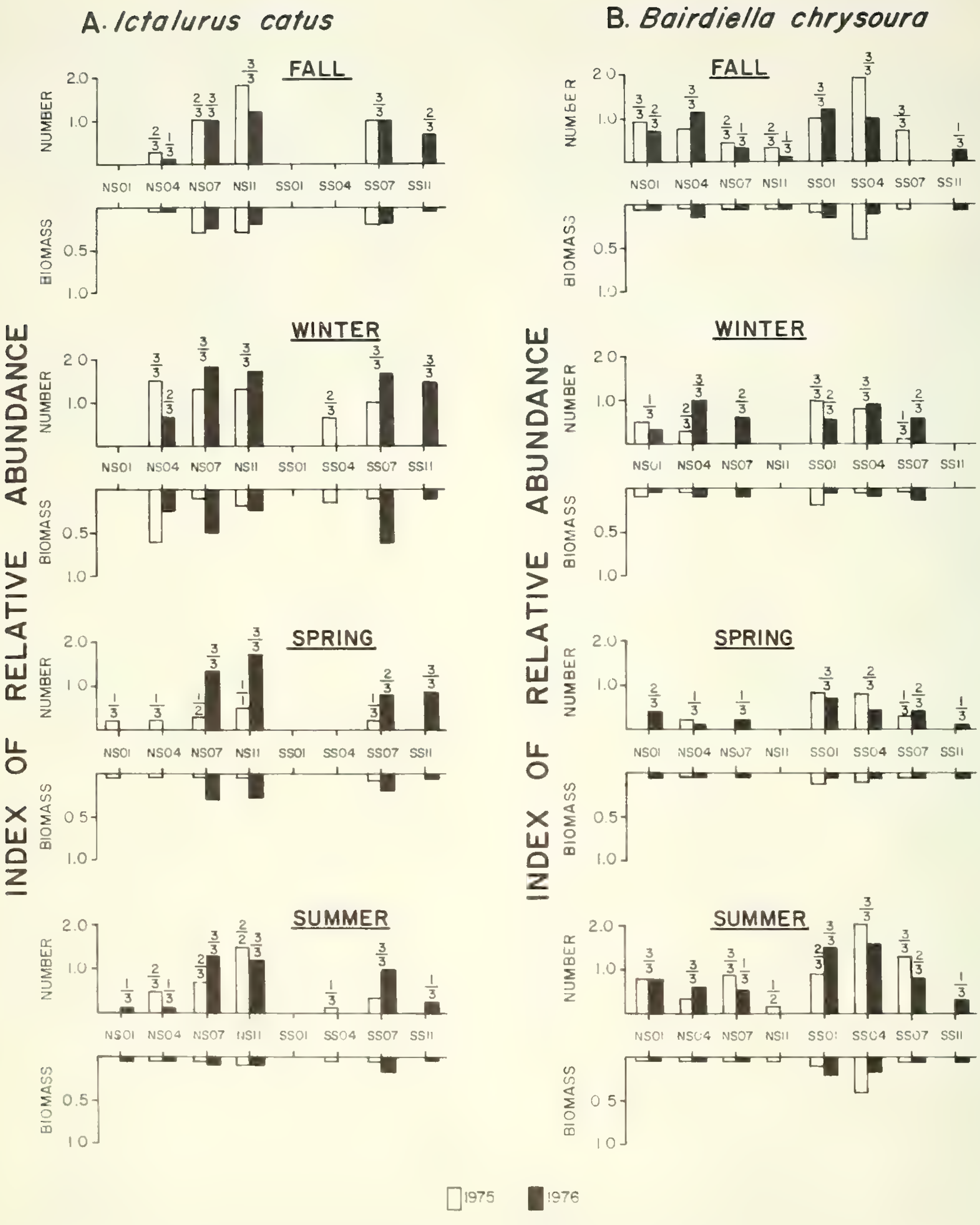

Figure 5.—Abundance of A) *Ictalurus catus* and B) *Bairdiella chrysoura* by station and season for the North and South Santee Rivers. Ratios over bars indicate number of collections where fishes were captured to total number of collections at a station.

prevalent in summer, which is coincidental with the spawning period of *I. catus* in South Carolina (Stevens 1959).

Bairdiella chrysoura, **the silver perch.**—*Bairdiella chrysoura* was present in the Santee system during all seasons, although abundance tended to increase during fall and summer in the South Santee River (Fig. 5). Silver perch showed no apparent preference for a particular portion of the salinity regime in the middle and lower reaches of the estuary since they were collected at all stations; however, catches did decline at the stations located further upriver (NS11 and SS11). *Bairdiella chrysoura* taken from the Santee system were young-of-the-year fish (Shealy et al. 1974; Chao and Musick 1977) within the size range of 20-100 mm.

Trinectes maculatus, **hogchoker.**—*Trinectes maculatus* was ubiquitous in the Santee system during all seasons (Fig. 6). Catches were greatest during fall in both the North and South Santee Rivers. Lower catches tended to be associated with sta-

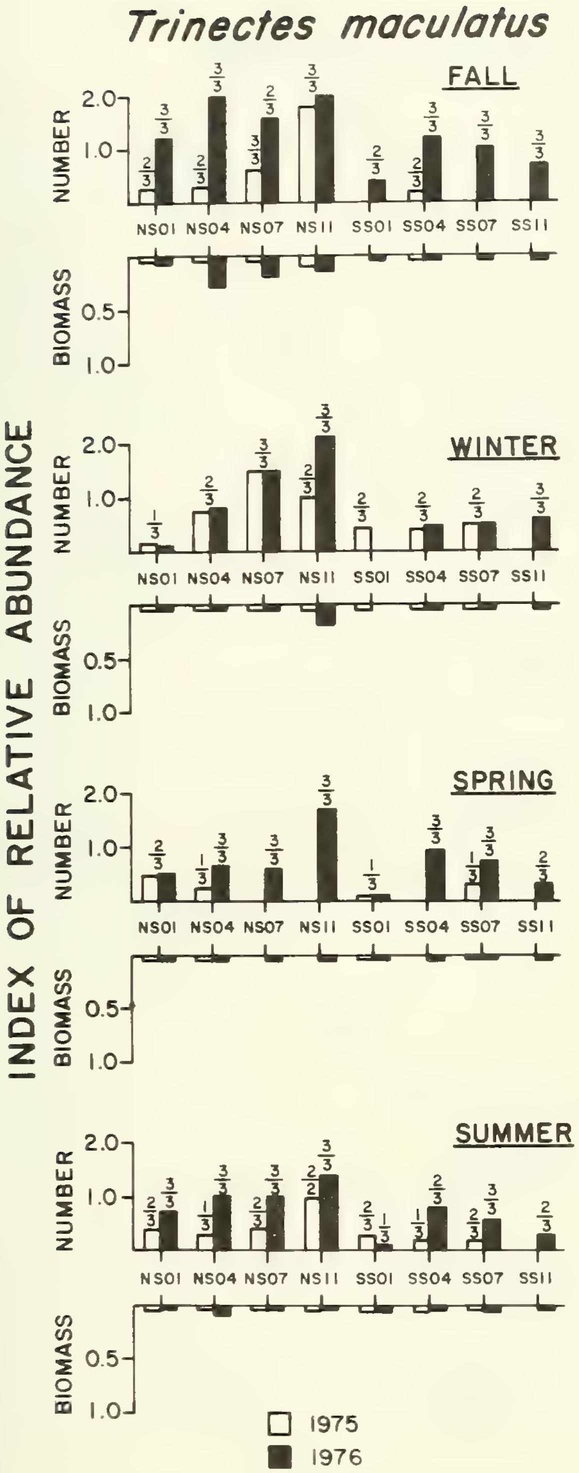

Figure 6.—Abundance of *Trinectes maculatus* by station and season for the North and South Santee Rivers. Ratios over bars indicate number of collections where fishes were captured to total number of collections at a station.

tions in proximity to the river mouths, which suggests an avoidance of euhaline areas by this fish. Lengths of hogchokers ranged from 20 to 175 mm, but most individuals were < 80 mm. These specimens probably represent young-of-the-year fish (Dovel et al. 1969) which appear during all seasons due to the extended spawning season of this species in the Carolinas (Hildebrand and Cable 1938).

Temporal and Spatial Distributions—Decapods

Distributional patterns of the most abundant decapod crustaceans, *P. setiferus*, *P. aztecus*, and *Callinectes sapidus*, are shown in Figures 7 and 8.

***Penaeus setiferus*, white shrimp.**—Catches of white shrimp were seasonal, with most individuals occurring in the Santee system during the fall and summer. Though common in both rivers, numerical abundance and biomass of white shrimp were greater in the South Santee River (Table 2), and catches appeared to be lower at the extreme upriver stations. This was particularly evident during winter and spring. Length-frequency distributions showed young-of-the-year white shrimp were present during summer in both rivers (Fig. 7). Sizes of shrimp collected increased during the other seasons, with the largest individuals collected in the spring. Similar findings were noted by Bishop and Shealy (1977) in a study of penaeid shrimp from South Carolina estuaries. They found that the largest numbers of shrimp were small, whereas larger individuals, which may be derived from the overwintering population or from an immigrating offshore population, occurred during fall and spring.

***Penaeus aztecus*, brown shrimp.**—Brown shrimp were most abundant in spring and summer (Fig. 8). These brown shrimp were rare in winter trawl collections. In other South Carolina estuaries, Bishop and Shealy (1977) noted that catches of brown shrimp were strongly seasonal, with most individuals collected in summer. The absence of brown shrimp in trawl catches during the winter months does not indicate that they are absent entirely from the estuary. Postlarval shrimp first enter South Carolina estuaries in January and are most abundant in February and March (Bearden[6]). Because it appears that postlarval white shrimp, and perhaps also brown shrimp, primarily occupy the shallow edges and creeks of estuaries where cover and preferred food are available (Bishop and Shealy 1977), we may have failed to sample this component of the shrimp population by restricting our collecting to the channel. It is also probable that 9-12 mm postlarvae are not retained by our 6 m otter trawl. Examination of length-frequency distributions (not shown) for brown shrimp collected in the Santee system showed a total absence of postlarvae in our trawl collections. Shrimp ranged from 30 to 145 mm, with most individuals in the 55-90 mm size range. The abundance of brown shrimp was also related to station location and, hence, salinity as reflected in only one occurrence of *P. aztecus* at the extreme upriver sites.

***Callinectes sapidus*, blue crab.**—The blue crab was caught throughout the North and South Santee Rivers during all seasons. Catches did not reflect strong seasonal changes, although fewer blue crabs were collected in summer in the North Santee River. Catches also appeared to be related to sampling location, with fewer blue crabs being caught at upriver stations. Size-frequency distribution of blue crabs covered a wide range of sizes from 15 to 195 mm, with smaller crabs (≤ 60 mm) occurring in fall.

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[6] Bearden, C. M. 1961. Notes on postlarvae of commercial shrimp (*Penaeus*) in South Carolina. Contrib. Bears Bluff Lab. No. 33, 8 p.

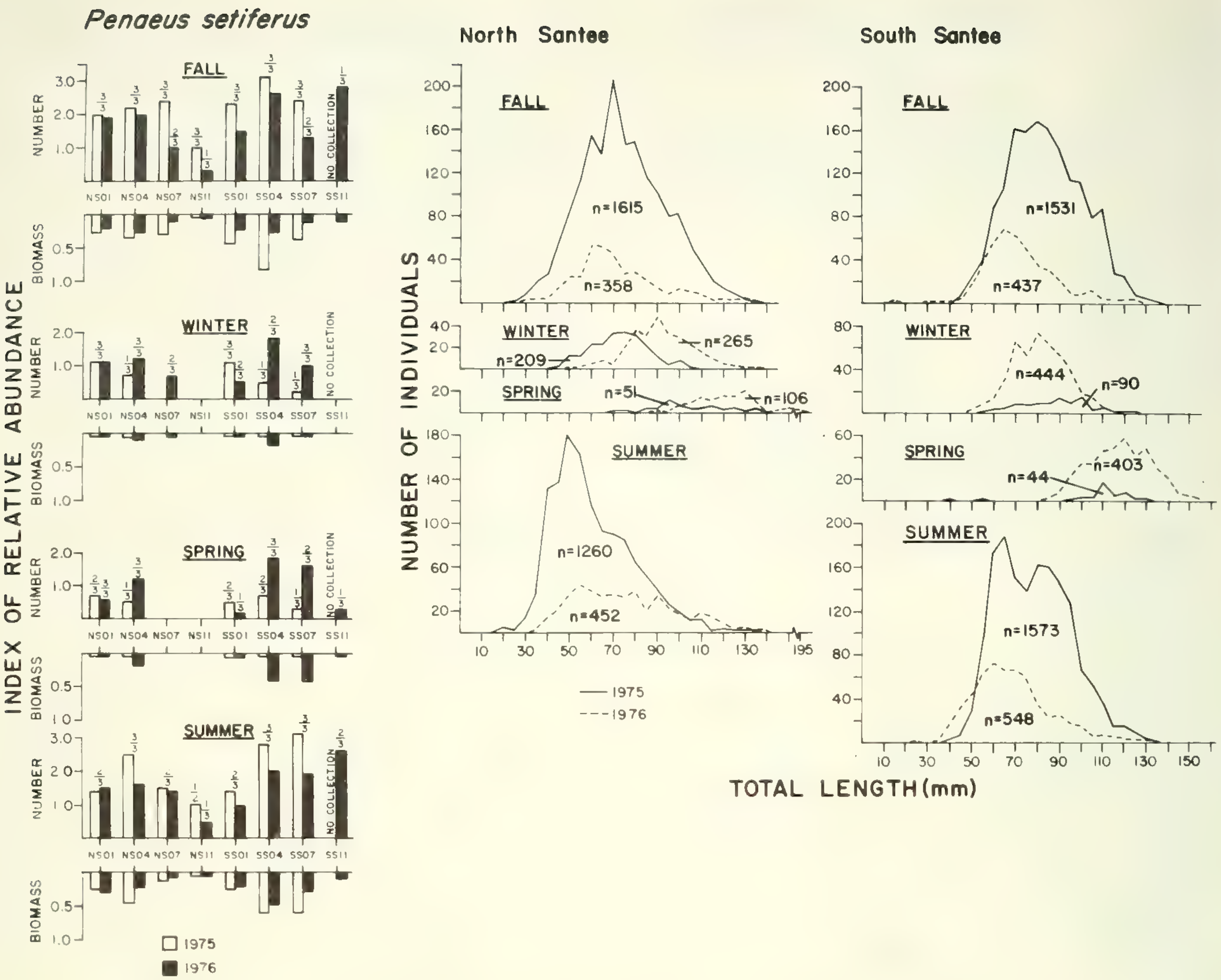

Figure 7.—Seasonal abundance and length-frequency distribution of *Penaeus setiferus* within the North and South Santee Rivers. Ratios over the bars indicate number of collections where shrimp were captured to total number of collections at a station.

Biomass Estimates

The estimated biomass, expressed in kg/ha, for fishes from the North and South Santee Rivers was lower than biomass estimates reported for other estuarine systems along the Gulf and east coasts of the United States (Table 5). Greatest biomass was obtained for northern temperate estuaries such as Narragansett Bay, R.I. (Oviatt and Nixon 1973), and Mystic River, Mass. (Haedrich and Haedrich 1947), while the number of fish per hectare was comparable between these northern estuaries and those in South Carolina. The reliability of our biomass estimates is confirmed by the identical value (3.8 kg/ha) obtained by Shealy et al. (1974) in other South Carolina estuaries.

Table 5.—Estimates of density and number of individuals/hectare for fishes caught by trawls from estuaries along the Gulf and east coasts of the United States.

Geographic area	Biomass (kg/ha)	Density (no./ha)	Gear	Reference
Mystic River, Mass.	26.16	462	4.8 m semiballoon trawl	Haedrich and Haedrich (1974)
Narragansett Bay, R.I.	31.68	290	9.2 m balloon trawl	Oviatt and Nixon (1973)
North Santee River, S.C.	3.9	287	6 m semiballoon trawl	present study
South Santee River, S.C.	3.8	303	6 m semiballoon trawl	present study
Cooper River — Charleston Harbor and Edisto system, S.C.	3.8	433	6 m semiballoon trawl	Shealy et al. (1974)
Doboy Sound, Ga.	10.7	4,190	12.2 m balloon shrimp trawl	Hoese (1973)
Galveston Bay, Tex.	16.57	8,511	3 m otter trawl	Bechtel and Copeland (1970)

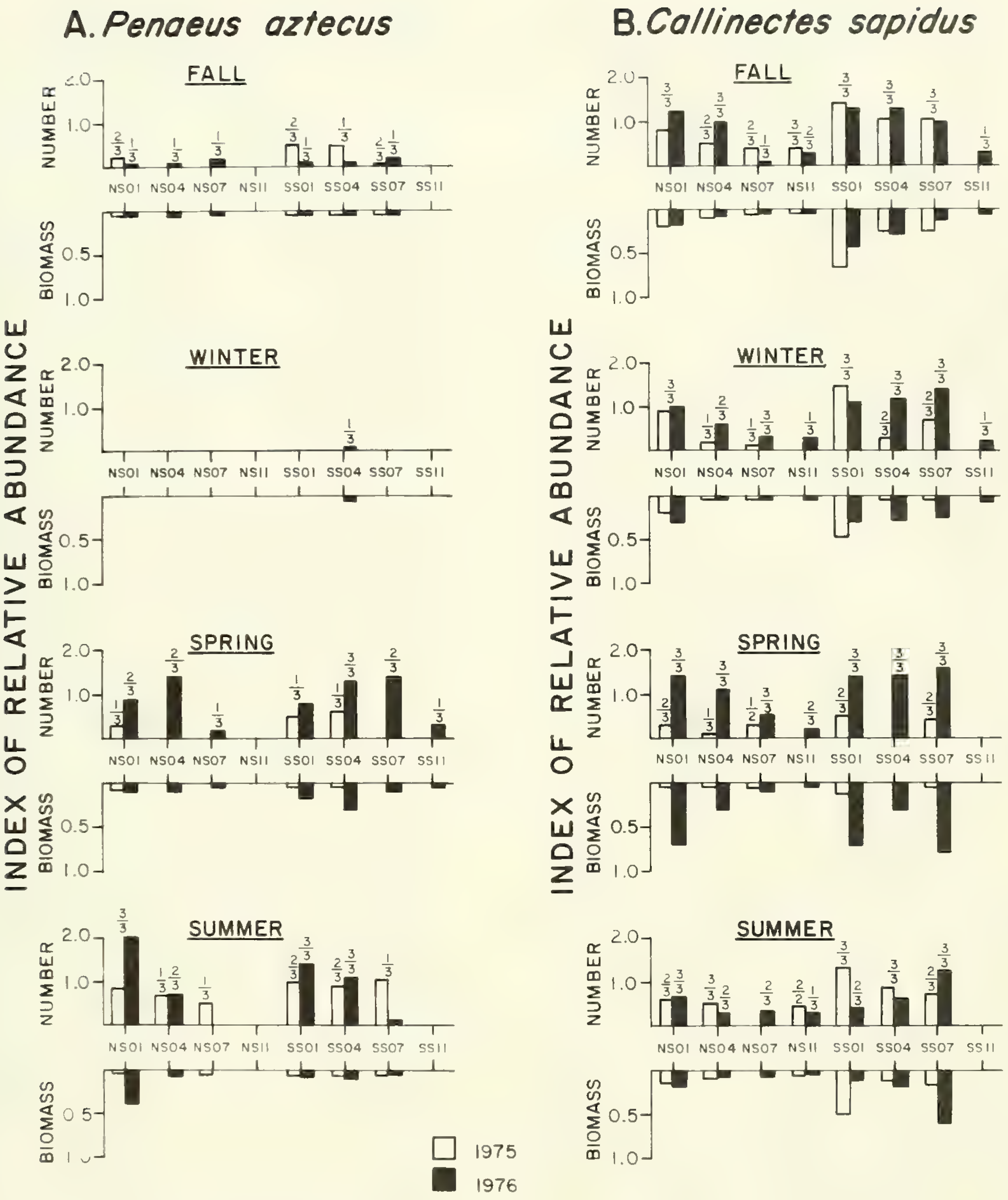

Figure 8.—Abundance of A) *Penaeus aztecus* and B) *Callinectes sapidus*. Ratios over the bars indicate number of collections where shrimp were captured to total number of collections at a station.

We obtained the following density estimates of decapod Crustacea from the Santee system:

	Biomass (kg/ha)	*Density (no./ha)*
South Santee	5.5	836
North Santee	1.9	255

These estimates are comparable to 6.1 kg/ha and 1,190 individuals/ha reported by Hoese (1973) for all invertebrates collected from Doboy Sound, Ga.

DISCUSSION

The distributional patterns of estuarine fishes and decapod Crustacea are influenced by numerous environmental factors. Factors such as salinity (e.g., Gunter 1938, 1945, 1961; Kilby 1955; Kinne 1966; Copeland and Bechtel 1974), temperature (Gunter and Hildebrand 1951; Reid 1954; Kinne 1963), substrate and detritus (Carr and Adams 1973; Mills 1975; Livingston et al. 1977), and river discharge (Aleem 1972; Ruello 1973; Livingston et al. 1977; Glaister 1978) influence animal distributions, with the extent of these influences dependent on spatial (habitat) dimensions as well as individual and specific tolerances. Laboratory studies are generally concerned with the interrelationships between biological response and multiple environmental factors acting in concert. However, application of laboratory methodology to ecological field studies is often quite difficult (Alderdice 1972), especially when dealing with mobile organisms such as fishes and decapods. The interpretation of results concerning distribution of these organisms within the Santee system is no exception to this difficulty. Nevertheless, it is possible to make some interpretation of community stability and specific distributional patterns based on the information collected over the intensive 2-yr sampling period.

The freshet in spring of 1975 appeared to have the most pronounced singular effect on species composition and abundance. The total number of species collected was lower at that time than at any other during the sampling period. This was particularly noticeable at the upriver stations. Abundance of individual species such as *Micropoganias undulatus*, *Anchoa mitchilli*, and *Trinectes maculatus* were also lower at these stations, which also may be attributable to flood effects. The effects on the decapod crustaceans and other numerically dominant fishes were not obvious. Calder et al. (1977) also reported alterations of species composition and density among benthic organisms collected from the Santee system during 1975 and 1976; however, they noted that the flood most affected benthos in the lower, usually more saline reaches of the river where an increase in species normally associated with greater freshwater intrusion into the lower estuary occurred. Others (Andrews 1973; Boesch et al. 1976) have noted that effects of lowered salinity from floods are greatest among meso- or polyhaline species, but the magnitudes of the effects differ for epifaunal, infaunal, and highly motile organisms. The depressed species number observed by us may reflect the tendency of fishes and decapods to escape from areas whose salinity is drastically lowered by floodwaters or, in the case of juveniles and small-bodied species, may be attributed to their being flushed downstream and out of the system.

The positive correlation between salinity and number of species in the Santee system agrees with results obtained by Gunter (1961), who noted that the number of species increased toward the lower reaches of estuaries where there occurred a mixture of euryhaline and marine stenohaline species. Hoff and Ibara (1977) found that in a New England estuary the number of species was greatest at stations which had the greatest fluctuation in salinity. Both species number and the community assemblages defined by us for the Santee system reflect increased diversity with proximity to the river mouth. Also, most assemblages defined for the Santee system consisted partially of euryhaline species. This is not an unusual occurrence within estuaries. Pearse (1936) noted that the estuarine fauna consists of marine or marine-derived species, and Weinstein (1979) stressed how depauperate the shallow marsh estuarine fauna would be if all transient marine species were removed. The distribution of the endemic estuarine species appeared to be more restricted than that of the marine transients. Nevertheless, we observed no abrupt faunal changes along the salinity gradient in the Santee system. Rather, the faunal assemblages overlap and do not exist as sharply delineated groups. This no doubt results from the different tolerances of juveniles and adults; the effect of salinity, in concert with other factors, on reproduction; and the highly compressed nature of salinity regimes in South Carolina estuaries as compared with many estuaries elsewhere.

As indicated by Pearson product-moment correlations, temperature, depth, and dissolved oxygen also affect community composition and abundance. The positive correlation of number of species and number of individuals with temperature is not at all surprising when one considers that species composition was most diverse during summer in both rivers. The huge influx of *Penaeus setiferus* and, to a lesser extent, *P. aztecus* into the estuary during summer and fall probably accounts for this correlation. The association between depth and number of species and individuals is more difficult to explain. All collections were made in the channel where depths ranged from 2 to 8 m in the North Santee River and from 1 to 5 m in the South Santee River. Although the range in depths sampled is slight, sufficient salinity stratification may exist in the Santee system so that higher salinity water occurs in the deeper channel regions. This may indeed be true for the South Santee River which receives less freshwater input. Also, salinity stratification may be greater on the floodtide, where samples were collected (Mathews footnote 4.) Since there is a positive correlation of species number and abundance, the correlation between depth and species composition and abundance is most likely a secondary effect. Similarly, the negative association between dissolved oxygen and abundance which was noted only for the South Santee River may be explained by lower dissolved oxygen values in the deeper, more saline channel areas. We realize the correlations are simplistic and that misinterpretation can result from speculating about cause and effect relations in correlation analysis (Sokal and Rohlf 1969). We are merely presenting this information as untested hypotheses.

Peaks of abundance for the numerically dominant species were not generally consistent over the 2-yr sampling period, but peaks of maximum richness (number of species) consistently occurred in summer. This observation compares favorably with those of Livingston et al. (1976) for fishes and invertebrates of Apalachicola Bay, Fla. They noted a relatively stable appearance of organisms from year to year, but considerable within-species variability in annual abundance. Temporal partitioning by our dominant species was not as noticeable as that described by Livingston et al. (1976). Dominant fishes were present in the Santee system throughout the year and showed fairly equitable abundances, although *M. undulatus* and *A. mitchilli* dominated our catches in winter and spring. *Penaeus setiferus* was much more regular in its pattern of appearance and abundance. Although regular fluctuations in species composition over time may indicate that an estuary is not stressed (Livingston et al. 1976), we feel that the year-round presence of stress-tolerant estuarine species better indicates temporal stability than overall stability of the estuarine system. We relate such occurance to a protracted spawning season in warm temperate areas which enable some element of the population, probably juveniles, to be present in the estuary year-round.

As the length-frequency polygons for selected species showed, the Santee system fish fauna captured during this study are primarily composed of immature fishes. Some larger mature individuals were collected, but the Santee system functions strongly as a juvenile fish habitat. The importance of estuaries as nursery areas is well documented (Gunter 1961; Wallace and Van der Elst 1975; Livingston et al. 1976; Weinstein 1979), and the attraction of young fish to estuaries is attributed to physiological suitability in terms of physiochemical features, an abundance of food, and protection from predators (Gunter 1961; Van Engel and Joseph 1968[7]; Wallace and Van der Elst 1975).

Although Wallace and Van der Elst (1975) and Livingston et al. (1976) also found that juveniles predominated in their samples, we suspect that sampling design and gear selectivity may have biased our results toward juvenile fishes. Our choice of fixed stations is certainly biased and lends itself to sampling error that would have been eliminated or reduced by a stratified random design (Markle 1976). We are, therefore, not able to determine the influence of movements by the fauna between the shoals and the channel. Because trawling is inherently variable (Taylor 1953), a repetitive method of collection would have allowed for statistical analysis of sampling efficiency to determine whether hauls taken at different times in different places did indeed have significantly different catches (Barnes and Bagenal 1951; Livingston 1976). However, even with successive samples, it is difficult to determine whether variability arises from the spatial distribution of the organisms or from the gear utilized (Taylor 1953). The susceptibility of organisms to fishing gear undoubtedly has influenced perception of spatial and temporal patterns (Markle 1976). The relatively small, fine-mesh bottom trawl used in our study is selective toward capture of slower, smaller fish. The relative absence of great numbers of older, larger fish from our trawl catches cannot be attributed entirely to migration or habitat selection, but in all likelihood reflects at least partial avoidance or escapement from the 6 m trawl (Shealy et al. 1974).

Habitat differences between adult and juvenile fishes may also account for the lack of large fish in our samples. Habitat preference varies with the species and also with age (Wallace and Van der Elst 1975; White and Chittenden 1976), so that feeding and residential grounds of adult fishes often are separate from their spawning grounds and nurseries. If spatial separation exists in South Carolina waters, then our survey was biased toward collection of juveniles found primarily in the channel. However, tidal creeks of the Cooper River which are comparable in salinity to those near the intermediate and upriver stations occupied in the Santee system were dominated by young-of-the-year marine euryhaline species such as *M. undulatus, A. mitchilli, L. xanthurus, B. chrysoura*, and *Paralichthys lethostigma* (Turner and Johnson 1974). Although the importance of tidal creeks in the Santee system as nursery areas can only be inferred, it is likely that the limitation of our survey to the channel resulted in minimal estimates of juvenile abundance for the river system.

The lower estimated biomass of fishes in the Santee system and other South Carolina estuaries is a direct function of the predominance of juvenile fishes in our catches and the efficiency of the sampling gear used. Whereas the density of fish from this area compares favorably with other regions, the biomass is much less. The large biomass of fishes in New England estuaries is primarily due to large catches of winter flounder, *Pseudopleuronectes americanus* (Oviatt and Nixon 1973; Haedrich and Haedrich 1974). A comparison of biomass and density estimates from this study and others (see Table 5) which used small trawls towed in the channel with investigations which incorporated shallow tidal creek and marsh sampling (e.g., Turner and Johnson 1974) indicates that the most productive areas are the marsh-creek habitat. Because these areas of the system were not sampled and the efficiency of our gear was low, our biomass and density estimates should also be considered minimal.

The presence of juvenile fishes in the Santee system is especially important in considerations concerning the effects of rediversion. Juvenile stages of resident species and many estuarine transient species are tolerant of and may even be most abundant in lower salinity water (Gunter 1961). Therefore, we believe that the nursery habitat for resident estuarine fishes will not be detrimentally affected and may be increased by rediversion.

Because rediverted flow of water through the Santee system will be moderate compared with the tremendous discharge of freshwater (9,100 m^3/s) put into the Chesapeake Bay estuarine system by Hurricane Agnes (Chesapeake Bay Research Council 1973), we do not anticipate that juvenile fishes will be passively swept from the Santee Rivers into the coastal area. In contrast, the food supply of fishes may be altered in that supplies of benthic organisms could increase in oligohaline and brackish water areas but decrease in lower reaches of the river. This effect could be particularly detrimental if it occurred during summer. Andrews (1973) noted that floods during warm seasons cause silting and an influx of excessive nutrients and organic matter, with consequent algal blooms and stratification of waters. These factors may, in turn, lead to low dissolved oxygen conditions. During other seasons, increased accumulations of detritus caused by increased riverflow and salinity alterations could actually be beneficial to microorganisms and detritivores such as isopods, amphipods, and some decapods. Detritus also serves as the major energy base utilized by juveniles of most fish species from sea grass beds (Carr and Adams 1973) and is probably important as a direct or indirect source of food for many fishes in the Santee system.

Sustained abundance of *Penaeus setiferus* in the Santee system is questionable following rediversion. Shrimp are known detritivores, and large areas of brackish/salt marsh and estuary with substantial land runoff are considered to be conducive to good shrimp production (Bishop and Shealy 1977). Rediversion will cause waters to inundate many areas and should result in a seaward progression of freshwater and brackish water plant communities. Because the total area of estuarine habitat should effectively be moved seaward, a decrease in actual acreage available as nursery habitat may result; yet lower salinity conditions are still likely to exert the greatest influence on shrimp production. Young *P. setiferus* are most abundant in salinities $<10‰$, whereas young *P. aztecus* are most abundant in salinities from 10 to 20‰ (Gunter et al. 1964). Despite these optimum ranges, Barrett and Gillespie (1973, 1975) have suggested that an inverse relationship exists between the amount of freshwater introduced into coastal Louisiana and the catches of brown and white shrimp. Also, increased turbidity and hypertrophy may inhibit photosynthesis so that an initial reduction in oxygen may occur in bottom waters. Others (Hildebrand and Gunter 1953; Copeland 1966; Aleem 1972; Glaister 1978) have noted a positive relationship between shrimp abundance and river discharge, but not all of these studies indicated that abundance was increased within the estuary.

Blue crabs will probably be little affected by rediversion because of their high mobility and tolerance of low-salinity conditions, but increased siltation from rediversion could hamper their respiration. Although blue crab populations sustained little damage following Hurricane Agnes, mortalities in Chesapeake Bay were attributed to increases siltation, low dissolved oxygen levels, and red tide (Chesapeake Bay Research Council 1973).

Van Engel, W. A., and E. B. Joseph. 1968. Characterization of coastal and estuarine fish nursery grounds as natural communities. U.S. Fish Wildl. Serv. Final Rep., 43 p.

From the available data and published literature, it appears that abundance of resident species of decapod crustaceans and fishes from the Santee system will be enhanced by rediversion if riverflow increase is gradual and properly regulated during natural freshets and warm weather periods. Such regulation will insure that salinities do not reach levels below tolerance and that hypertrophic conditions do not occur. On the other hand, the effect of rediversion on transient species such as sciaenid fishes and penaeid shrimps may not be beneficial. A decrease in nursery habitat following rediversion would lower abundance of these species. This is indicated by two aspects of our results: Both biomass and density of the South Santee River, which currently receives less freshwater input, were higher than that of the North Santee River; and both abundance and biomass of dominant species appear to be generally lower at the stations furthest upriver. Species diversity will undoubtedly decrease due to decreased utilization of the lower portion of the Santee Rivers by marine stenohaline species. Lower salinity conditions at and near the mouth should deter penetration of the estuary by these species. Whether decreased abundance of marine transients in the vicinity of the upriver stations following rediversion will be offset by more optimum salinity conditions and increased abundance nearer the mouths of the rivers is supposition. It appears that rediversion is certain; therefore, it is imperative that careful monitoring of biological and hydrographic conditions occur during and after rediversion in order to ascertain effects on the estuarine biota.

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Equipment and Techniques for Handling Northern Fur Seals

Roger L. Gentry and John R. Holt

July 1982

U.S. DEPARTMENT OF COMMERCE
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Equipment and Techniques for Handling Northern Fur Seals

Roger L. Gentry and John R. Holt

July 1982

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Equipment and Techniques for Handling Northern Fur Seals

ROGER L. GENTRY and JOHN R. HOLT[1]

ABSTRACT

This paper describes techniques for capturing, immobilizing, and marking northern fur seals, *Callorhinus ursinus*, of all ages and both sexes. It is intended as an explicit field manual for handling this species, and as a source of ideas for handling other eared seals, wild or captive. Furthermore, it advocates capturing and manipulating wild seals as an approach to investigating behavior. The paper deals only with short term physical restraint; immobilization with drugs is not considered. Emphasis is placed on the importance of animal behavior in determining the design of capture equipment and techniques. Because of this dependence, capture techniques must change seasonally as behavior changes, and different techniques may be needed for different species. A wide range of techniques is considered, from the capture of single pups to the mass captures of adult females.

INTRODUCTION

Field studies on the Otariidae (fur seals and sea lions) have not matured beyond the level of passively observing wild populations (Gentry 1975). The limitations of this approach are obvious; it will never reveal cause and effect relationships, and it will not serve for detailed hypothesis testing. Without adopting more complex field methodology otariid studies are not likely to match the level of sophistication reached in primate field studies (compare Ronald and Mansfield 1975 against Chevalier-Skolnikoff and Poirier 1977).

The use of manipulative field experiments by primatologists marks the difference between the two disciplines. Otariid researchers too can perform experiments on wild animals given a set of handling techniques, some simple tools, and the conviction that small disturbances are justifiable. Obviously, not every animal of every species can be manipulated. But at least some animals of most species can be. The subject of this manual, the northern fur seal, is one of the more tractable otariids.

The equipment and techniques described here were developed during the past 8 yr. Some of the methods have been used successfully on the Afro-Australian fur seal, *Arctocephalus pusillus pusillus*, and the Antarctic fur seal, *A. gazella*. With modifications, the techniques and equipment could be used on other otariids as well. Some of the equipment we describe have had a long history of successful use in the Pribilof Islands, and some we have invented. We developed the techniques for using this equipment around two criteria specific to our behavioral studies: 1) the methods of capture and handling a given animal should cause the least possible disturbance to other seals and 2) the prolonged debilitating effects of drugs are to be avoided. Because other workers will have different criteria, this manual presents convenient starting points for the development of techniques that meet other criteria. That is, our techniques are not offered as "correct," only successful.

We intend this as a field manual for those who have had no previous experience with otariids and who must capture and handle animals without the aid of experienced help. The immobilization techniques are applicable to any captive otariids. All the equipment we describe can be built and maintained in the field with minimal tools. Techniques for keeping seals in captivity have recently been reviewed (Spotte 1980).

IMPORTANCE OF BEHAVIOR

The key to successfully handling wild otariids is knowing their behavior thoroughly. Knowing their strengths and weaknesses often suggests a design for some special equipment. But more importantly, knowledge of how animals act reduces one's fear of the animals and fosters the calm judgement under stress that capture situations demand. Inevitably, judgement is most important at the moment of greatest physical exertion during a capture. The use of too much force can injure or kill the seal, but insufficient force can allow the seal to escape and endanger humans. A knowledge of behavior gives one the judgement to maintain a balance between force and finesse, and the flexibility to improvise during captures. No two animals are exactly alike, and no one set of procedures works equally well in all captures. Furthermore, the behavior of animals changes throughout the year so extensively that seasonal changes in capture techniques are required for a given age and sex (Table 1).

Most of the techniques in this manual take advantage of some special behavioral trait of northern fur seals. If a different species does not share that trait the technique will not work as described. However, the approach to developing techniques should be the same for all species. Basically, one learns the behavioral traits well, and then uses those traits for their direct effect, or selectively avoids them. For example, northern fur seal males aggressively charge a human in response to a direct, fixed stare. Charging is desirable when trying to lasso the seal properly, and it can be induced by staring. In contrast, charging is not desirable when capturing adult females from within the male's territory, and it may be prevented by averting the face from the male. Where possible we advocate capture by trickery, rather than by force.

There are four generalizations about otariid behavior that influence handling techniques and equipment. First, the animals will not attack a human with the same determination as they would another seal. It is usually not appropriate to bolt and run from an attack, rather to cautiously withdraw. Overreaction to attack can jeopardize your coworkers. Second, otariids are physically strongest in the vertical direction due to the development of their pectoral muscles. They are powerless on their backs or suspended in the air. Unlike phocids they are relatively weak in side-to-side motions, and the design of restraint

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Table 1.—Abbreviated chronology of the fur seal breeding season.

Date	Comments
Mid-May	First territorial adult males arrive.
Late May	First juvenile males arrive along beaches and on haulout grounds. Best time to capture adult males on territory.
Early June	First females arrive and form small groups along water's edge. Arrival of new territorial males decreases sharply.
Mid-June	Large juvenile males appear around periphery of breeding areas; number of juvenile males on hauling grounds increases.
Late June	Females far enough inland and births are frequent enough to allow female captures (noose method) on inland borders of breeding areas.
5 July	Peak of pupping season; best time to capture adult females using noose method.
12-15 July	Peak of copulations.
25 July	Births too infrequent and females too wary to permit captures with a noose. Use hoop net technique. Territorial males abandon territories and can be captured by hoop net; 2-yr-old juvenile males arrive.
Early August	Small adult males begin short tenures on territories. Mass captures of females and pups is now possible. Females begin to appear on hauling grounds.
Late August	Many females on hauling grounds, most large males absent.
Late August, early September	Yearling juvenile males arrive; older juveniles move onto breeding areas. All pups of the year entering the sea.
Mid-September	Virtually all males absent, no territorial structure.
Mid-October	Females begin to wean pups of the year and leave the island for the season.
Mid-November	Very few animals remain.

equipment can exploit this fact. Third, despite their lack of lateral power, their biting motions are quickest in that direction. Exercise extreme caution while working around the necks, ears, or front flippers of unrestrained seals. Last, when they bite they usually make a single tearing slash at the very surface of their target. People handling northern fur seals are spared some injury by wearing loose-fitting rain clothing which the seals bite first.

DESCRIPTIONS OF EQUIPMENT

Noose Pole (or Choker) (Fig. 1)

This is the most broadly applicable gear used in handling fur seals. It consists of a loop of rope at the end of a light-weight pole. The loop goes over the animal's head and is twisted tightly by rotating the pole around its long axis. When properly applied the choker prevents the animal from fleeing or attacking. It allows a single person to restrict the movements of seals weighing up to 60-65 kg, including adult females and 3-4 yr-old males. A second person grasping the hind flippers is required for lifting the animal or moving it more than a few meters. For holding seals motionless a restraint bar is recommended (described below).

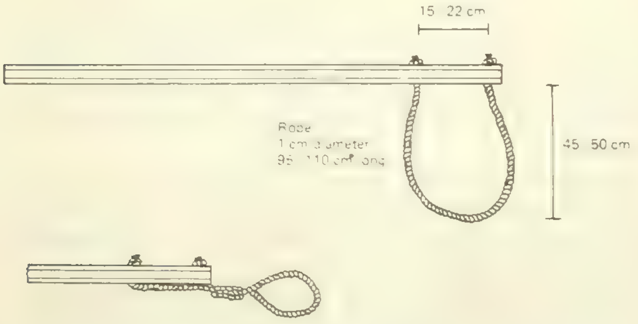

Figure 1.—A noose pole or choker used to control small fur seals. The open loop is placed over the animal's head and the handle is rotated until the loop tightens around the seal's neck. See also Figure 10.

The poles are most frequently cut from 4 cm × 4 cm clear fir (2 in × 2 in dimension lumber) of varying lengths determined by the application. Corners of the lumber are beveled to an octagonal shape to reduce weight and improve the grip. The rope forming the noose is typically 1 cm (3/8 in) hemp. The rope is threaded through two holes drilled 15-23 cm (6-9 in) apart near the end of the pole and knotted on the opposite side. The rope loop is 95-105 cm (38-42 in) long, providing a loop 45-50 cm (18-20 in) deep.

In making chokers, a balance is struck between weight and strength; good quality lumber is essential. Breakage usually occurs in poles with knots. Animals snapping at the choker or noose may bite through the rope or gradually chew away the end of the choker pole, so that it is weakened or the rope noose may pull out. For these reasons it is advisable to have a spare choker on hand. Also for these reasons it is not advisable to use the metal nooses (commercially available) used to handle dogs. For restraining animals already contained in a holding pen or transport box, a 2-2.5 m (6-8 ft) long choker provides a good combination of physical control, safe working distance, and convenience for working in confined spaces. Longer chokers (up to 5 m) are used for other applications, such as capturing adult females on the rookery.

Bamboo Poles

These are used in varying lengths for fending off aggressive animals or for herding groups of animals. Poles 5 m long are appropriate for adult males, but shorter lengths may be used when working with smaller animals. The bamboo provides a good combination of light weight and high compression strength. The best defense with these poles is a pushing or jabbing motion aimed at the chest or throat.

Diagonal wraps of fiber glass (strapping) tape with considerable overlap at the ends of the pole, but with 5-10 cm between wraps near the middle add strength to the pole and greatly decrease splitting. Bamboo stored in a dry, heated building may split badly enough to be useless. With a lightweight cord loop at one end, a bamboo pole makes an effective long choker for snaring fur seal pups.

Restraint Bar (or Board) (Fig. 2)

This device is used for holding small animals stationary, by restraining the head so that marks or tags can be applied, harnesses can be fitted, or other physical manipulations accomplished without danger of the workers being bitten. The restraint bar consists of a heavy wooden plank, and a wooden yoke in the shape of an upright U. A metal bar is attached with a pivot at one end of the plank so that the bar can close down on the plank scissors-fashion. The bar has an inverted U or yoke near its center which fits over the animal's neck and into the wooden yolk to form a circle around the animal's neck when the bar is closed. Both the wooden yoke and the U shape in the metal bar may be fairly broad, typically 18 cm wide and 13 cm deep (7 × 5 in). When the bar is closed, the opening between the bar and the wooden yoke should be about 10 cm (4 in). The wooden yoke is generally made of two pieces of 5 cm (2 in) dimension lumber laid out parallel on the base plank about 2.5-5 cm (1-2 in) apart, so that when the metal bar closes down, it falls between the two wooden yoke pieces and can lie flat against the base plank. The plank is 5 × 20 cm (2 × 8 in) dimension lumber. The bar is made from 2 cm inside diameter iron pipe (3/4 in plumbing stock) or thick-walled electrical conduit. Metal conduit is much more easily bent to the sharp curves necessary: kinks in the pipe drastically reduce the strength and life-span of the bar.

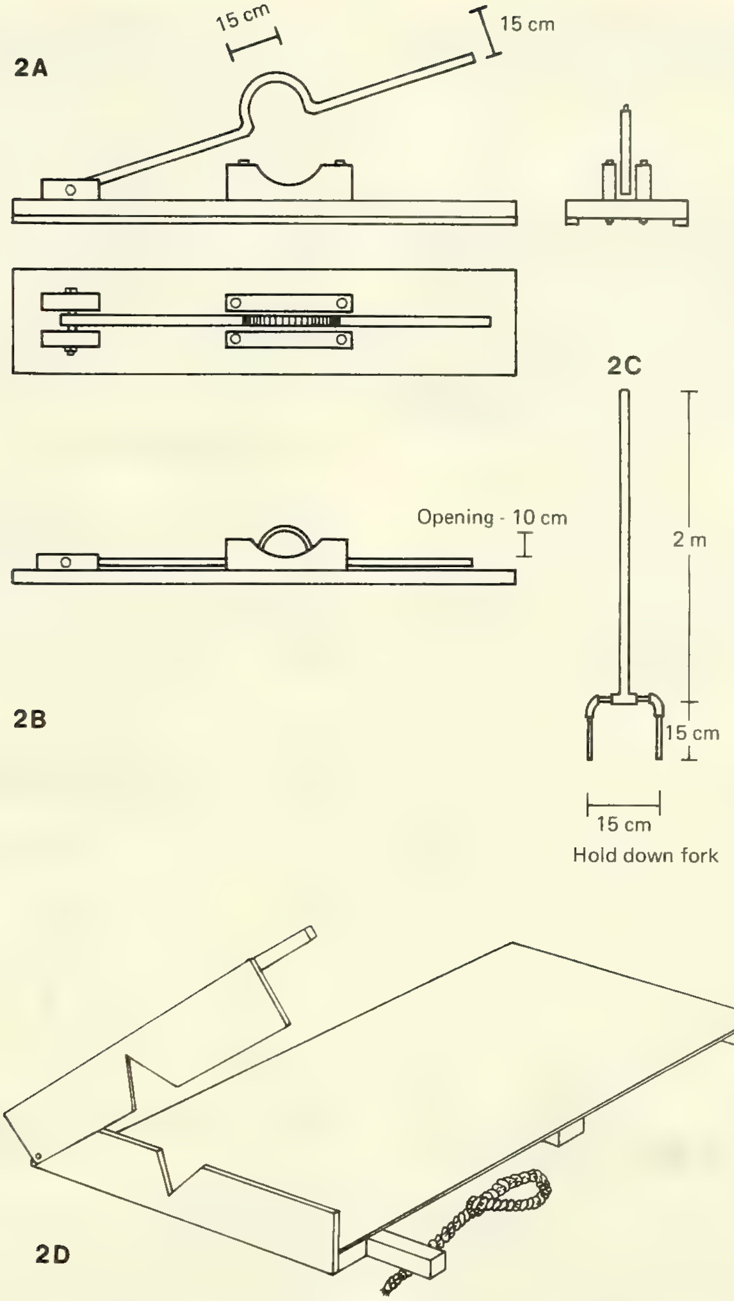

Figure 2.—Restraint devices used to immobilize small to medium sized fur seals. A) A bar with a deep yolk which restrains by preventing the animal from backing up. B) A bar with a shallow yolk which restrains by pressing down on the seal's neck. C) A hold-down fork that pins the animal's head to the ground using hand pressure only. D) A board with "V" notches which wedge behind the skull and prevent the animal from backing up.

This bar provides restraint by producing downward pressure on the animal's neck. The sides of the inverted U and wooden yoke prevent the animal from turning its head from side to side, so that the animal can escape only by "backing out" of the bar. Downward pressure on the bar may restrict the animal's air passage, and inhibit breathing. For this reason one person must always attend the seal, varying the pressure on the bar to maintain a balance between restraint and asphyxia. This person must be familiar with symptoms which seals display under physical and physiological stress. This device is strong and portable, but large, strong seals can stand up with the restraint bar around their necks.

Another version of the restraint bar (Fig. 2d) uses a plywood board with two vertical plywood "blades" attached to one end. The upper blade is hinged at one side and passes in front of the attached lower blade when closed. Each blade has a 65° angle V notch, 20 cm (8 in) deep, cut in its center so that the closed blades create a diamond shaped opening. Restraint results from the opening being adjusted around the neck so that the skull cannot be withdrawn backward through the diamond. The upper blade can be tied in place, and straps can be placed over the seal so that the animal need not be attended continually. The seal's airway cannot be obstructed by downward pressure because of the depth of the lower V notch. This board can be lifted so that the seal can be carried about. Large seals cannot stand up in this device because they push against the board rather than the ground. Milk samples can be taken from restrained females through a sliding door under the teats.[2]

Hold-Down Fork (Fig. 2c)

This is a 2 m long metal pole with a U-shaped fork at one end. The prongs of the fork are about 15 cm long and about 15 cm apart. The entire device can be constructed from galvanized plumbing pipe and pipe fittings. It is used to pin the head of a small animal to the ground. It may be used in place of a hold-down bar in situations where the animal must be held in position at the location of capture. It is best applied when the animal must be restrained for only very short periods of time. Restraint with the hold-down fork is not nearly as secure as with the restraint bar.

Nets

Large hoop nets (Fig. 3) have been used successfully in various applications. The basic hoop, fabricated of 3.75 cm (1 1/2 in) aluminum tubing is 0.75 m (30 in) in diameter, and has a 4 m handle. Two 30 cm long diagonal braces extend from the handle to the rim of the hoop (not quite tangent to the perimeter).

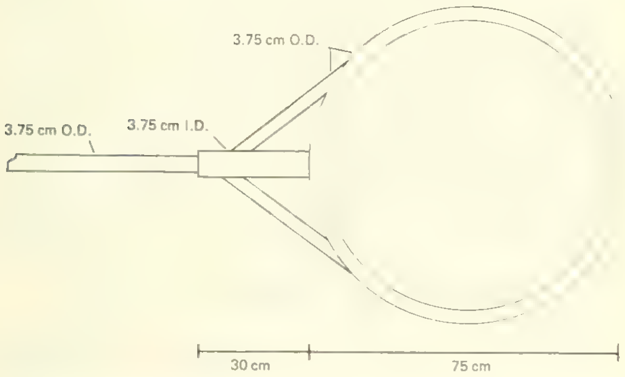

Figure 3.—A hoop net with a handle of aluminum tubing inserted inside a piece of aluminum pipe welded and braced to the hoop.

Proper construction of this hoop will greatly reduce its weight without loss of strength. Our most satisfactory design combines aluminum pipe (thick walled) and aluminum tubing (thin walled). The circular hoop and diagonal braces are made of tubing. Into a short "handle" (about 30 cm) of aluminum pipe attached to the hoop is inserted a longer (3 m) handle of aluminum tubing. This arrangement weighs little but provides sufficient strength at the point of maximum stress where the handle meets the hoop.

Nets of varying dimensions and weights are attached to this hoop depending upon the size of animals to be caught. The most frequently used net type is nylon or polypropylene fishing net with roughly 10 cm mesh openings.

For capturing adult females and small subadult males, a net with a slight taper and a depth of 1.25-1.5 m is appropriate. Pups may be caught with this net also, but if numerous pup captures are to be made, a smaller hoop and net will be less cumbersome.

For capturing large subadult males weighing 135-160 kg (300-350 lb), just smaller than adult territorial males, the net should be about 2 m deep with little or no taper. Into the foot of this net is sewn a bag of canvas or fiber-reinforced plastic. The purpose of the bag is to restrict the animal's vision, which encourages it to rest more quietly while under restraint. Without this restriction the animal will continue to struggle, and males of this size are too strong to be restrained by force alone. Instead of a bag, a sleeve may be used with grommets installed along its border on the deep end. A strong purse string may be woven through these grommets and the ends of the net outside the bag. The capture is made with the net pursed. The bag is 60-75 cm deep and the same diameter as the inside of the net. The bag should be sewn into the net deeply enough so that when a captured animal pushes against the bag, the force is restrained by the strong net and not by the bag within the net. The bag is deep enough to go over the animal's head and part way down it shoulders.

Transport Boxes (Fig.4)

These are small lightweight boxes with wire mesh tops used for transporting small animals that two people can carry. Dimensions are 60 cm × 60 cm × 80 cm (24 in × 24 in × 32 in) and allow comfortable posture and some movement for an adult female, with space for her pup. The boxes are small enough to be loaded easily on a small aircraft. "Stretcher" type handles are removable to save space.

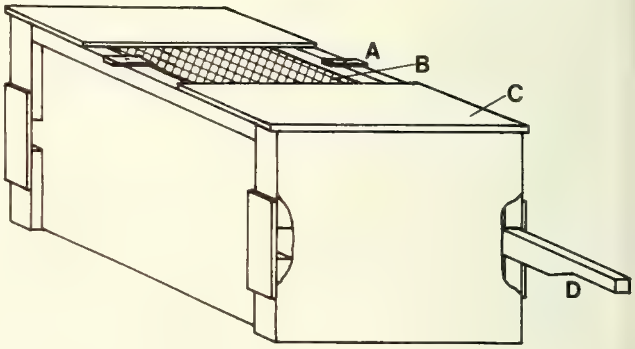

Figure 4.—A transport box with removable handles used to carry fur seal females and small males.

Boxes are built with 1 cm (3/8 in) plywood and 5 × 5 cm (2 × 2 in) lumber. Galvanized hardware cloth (0.6 cm mesh) is used for the top. Completely removable tops are more versatile than hinged tops. The plywood cross braces on the tops provide rigidity, safe handholds, and some visual screening of the animals from the box carriers. A simple, quick-acting latch mechanism is advantageous. For long journeys a raised false bottom of slats may be added to reduce contact of the animals with their own excrement. See illustration for construction details.

Adult Male Marking Box (Fig. 5)

This apparatus has been described in detail previously (Gentry and Johnson 1978); basic information about the device will be repeated here. The principle on which the box operates is physical immobilization through downward pressure. The top of the box can be lowered until the animal is pressed between the top and a false bottom. In that position small doors in the top provide access to various parts of the seal's body for tagging and marking. Also the top and false bottom with the seal sandwiched between can be hoisted as a unit for weighing.

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[2] Daniel Costa, PRL, Scripps Institution of Oceanography, La Jolla, CA 92037, pers. commun. July 1981.

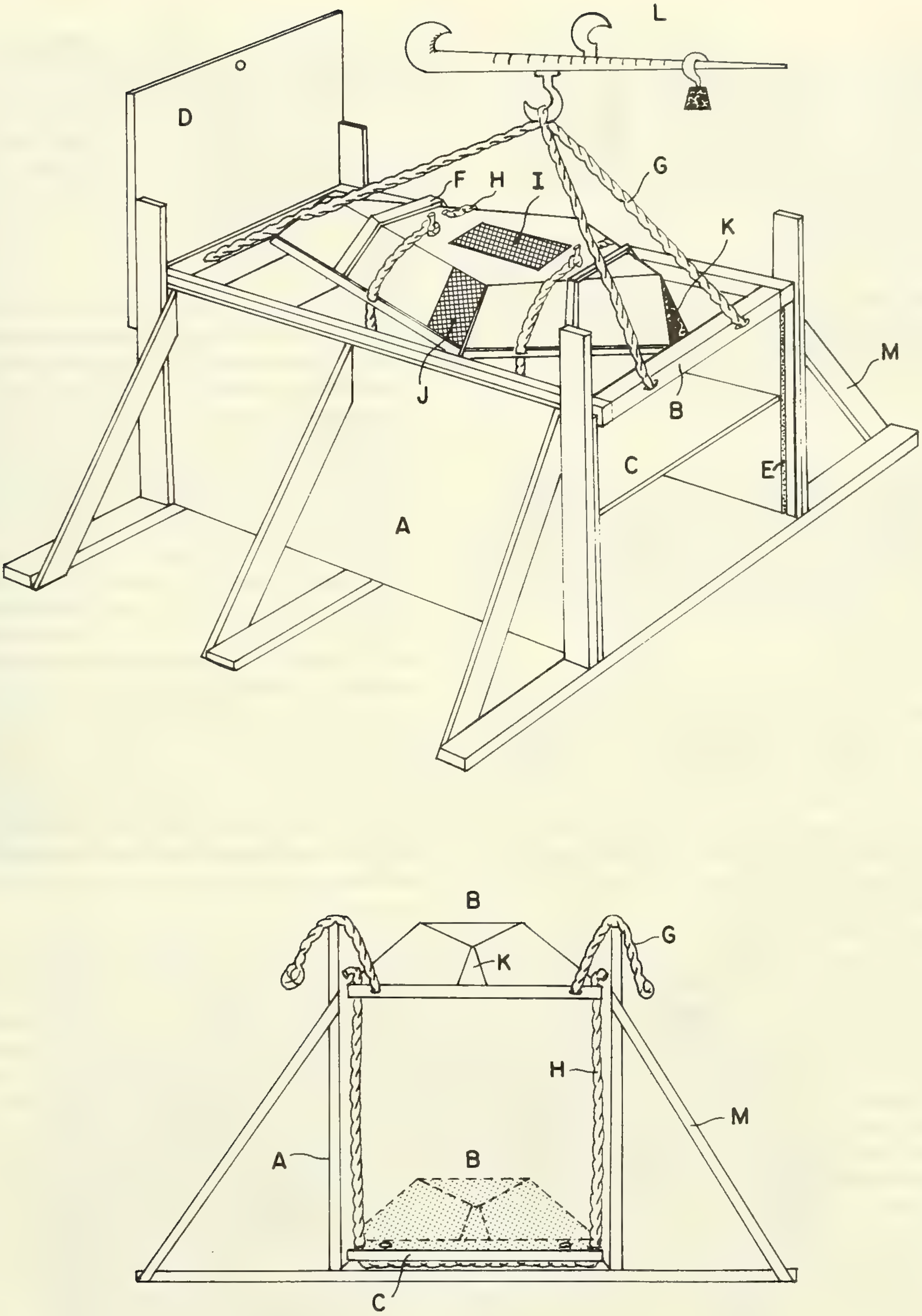

Figure 5.—A box with a specially shaped, moveable roof used to immobilize adult male fur seals using downward pressure. (Reprinted with permission of the Journal of Wildlife Management.)

The box measures 2.4 × 1.1 × 1.2 m high (96 × 42 × 48 in). Construction is of 2 cm (3/4 in) plywood, thoroughly braced on the outside. The box has vertically sliding doors in each end. The removable top and false bottom are small enough to slide easily up and down inside the box. The top has an overall oval dome shape (roughly the shape of a prone male seal). Six persons can carry the assembled box for short distances.

Noise Makers

Lightweight metal cans (2 to 5 gal fuel containers are appropriate) with a few loose rocks inside, make effective noise makers that are useful for driving large numbers of animals. These are shaken, or are rolled along the ground behind moving animals.

Marking

Some kinds of research require repeated observations on the individual animals within a season, or following known animals over periods of several years. A few animals (particularly older males) may be recognized repeatedly by characteristic scars or physical abnormalities. However, positive identification from one field season to the next, or among different observers requires unequivocal marking of individual animals.

Tags

Flipper tags have been the mainstay of the marking effort in the fur seal program. Although we may apply more than one type of mark to a given animal, the flipper tag serves as the ultimate identifier. Two types of tags are currently in use, both originally designed as cattle ear tags.

Monel tags are U shaped plates of monel metal, which, when closed, form a flattened oval ring through the animal's flipper. Once applied the tags measure approximately 0.9 cm wide by 4 cm long with numerals 0.6 cm high stamped into the metal. In good weather conditions these tags can be read with binoculars at distances up to 3 or 4 m, or with high-powered spotting telescopes (45 to 60×) up to 35 or 40 m away. Monel tags cause mortality. Their use on pups has been discontinued in favor of toe clipping (Johnson 1971).

Because the portion of the tag that penetrates the flipper is a flat blade (about 0.6 cm across), some injury may occur to the animals as the tags rotate. (We have no confident assessments of adult mortality which may be introduced by these tags, though we have seen many adult animals wearing the tags without apparent adverse physical effects.) Some improvement in the tag may be made by bending the portion that penetrates the flipper into a round post. This modification can be made with pliers, and the burred edges eased with a motor-driven wire wheel.

Jumbo Rototags are two-part plastic tags 1.9 cm by 4.4 cm. They come in various colors with 1.25 cm high black numerals heat-stamped on both the upper and lower parts. These tags can be read by eye at 3-5 m, and may be read up to 100 m away (occasionally farther) with spotting telescopes.

One advantage of the Rototag is that the portion which penetrates the flipper is a round post (about 0.5 cm in diameter) which allows the tag to spin freely on its axis without enlarging the hole in the flipper. We do not yet have estimates of loss rate for Rototags in fur seals. Some tags pull through the hole in the flipper, and a few tags break. Tags applied 5 yr ago still have discernable numbers though some more recently applied tags have faded. (Note: Rototags seem more adequate for fur seals than for other otariids (Hobbs and Russell 1979).) The tags are applied to the posterior (trailing) edge of the front flipper, about 3 cm forward of the edge. There are two sites for tag placement. One site is about 2 cm distal to the hairline across the flipper. This site contains veins and nerve tissue, so tagging should be done cautiously. In adult males the hairline site is too thick and fibrous to penetrate with Rototags, so either a monel tag can be used, or the animal can be tagged at the second site, between the 4th and 5th digits. The drawback of the latter site is that tags there are easily torn out, especially in large males.

Pelage Marks

In addition to tags we generally apply a larger, more visible mark to the pelage. Large (15-20 cm high) letter-number combinations may be painted on the animals with bleach. We use a catalytic mixture normally available only to beauticians called "Lady Clairol Ultra-Blue." This viscous liquid is painted on the dry or barely damp fur, and rubbed in. Within 1 to 3 d the dark guard hair is marked with a pale color ranging from a very bright beige to a fairly dark orange. If the mixture is rubbed into the fur carefully, and the animal does not go immediately into the water, the bleach can generally be expected to "take," though our results have been varied; rarely does the process fail to make a visible mark. A bleach mark considered "good" in one year can usually be seen the following year, though it will generally be faint and may not be readable. It is rare for bleach marks to last more than one winter. This means that for an animal to be followed for more than 1 yr (except by tags), it must be recaptured the following season and be remarked.

Marks may also be clipped in the guard hair with scissors. Clipping away the dark guard hair reveals the lighter underfur beneath, and leaves a readable mark without danger or injury to the animal. We have no assessment of thermal stress caused by this mark. Clipping marks is very slow work and the clipper's hands quickly tire. Clipped marks last perfectly well through one breeding season, but cannot be seen the following season. Marks clipped in the fur of pups early in the season will probably be completely grown in by mid- to late-October.

Two types of paint have been used with some success. Quick-drying highway or traffic paint adheres to the guard hair reasonably well, and if the animal does not go immediately into the water, the paint may stick for 2 to 3 wk. We use this paint to temporarily mark animals which we intend to capture and mark permanently at some later date. The paint can be applied with a sponge attached to the end of a bamboo pole. Identification by this method involves memorizing the irregular splotch marks of paint, or drawing sketches of the patterns on history cards for individual animals. The history cards should by updated frequently, since the paint gradually flecks off, and the size, shape, and pattern of the marks change with time.

Workers under contract to the National Marine Mammal Laboratory used a plastic resin naphtha-based paint marketed by Lenmar, Inc., which provided long-lasting (6 to 8 wk) marks in the pelage of fur seals (Griben 1979). Later examination of pelts from animals taken in the commercial harvest on St. Paul Island revealed abnormalities in both the guard hair and the underfur where paint was applied. We do not recommend the use of this naphtha-based paint on fur-bearing animals until more work is done to determine potential damaging effects.

We believe that branding with a hot iron is, on balance, the most humane way to mark seals permanently with a large mark suitable for behavioral research. It is preferable to slightly injure an animal once in its life by branding than to recapture it every year to refresh temporary marks, such as bleach or hair clipping provide. When executed carefully, skin-branding provides a good mark without serious injury. We have followed skin brands on some seals for 5 yr.

We use a hot iron in two ways. For temporary marks that last through one season, but that may not be readable in the following season, we use the iron to singe away the guard hair, leaving the lighter underfur exposed. Once the equipment is set up, this "hair-branding" technique is very fast for marking large numbers of animals. The cleanest marks result from branding wet animals because water prevents the hair around the brand area from flaming. If equipment is available this technique is preferable to hair clipping.

Skin-branding requires more caution and attention to detail than hair-branding. The very dense underfur absorbs large amounts of heat from the branding iron and, when burned, this fur may cake up to form a protective layer over the skin. We lightly singe the hair, then brush away the caked ash with a glove or a stout brush until the unburned underfur is visible. Then the still-hot iron is carefully reapplied to the same area, and hair is lightly singed again. Three or four applications of the iron may be necessary before the iron contacts the skin directly. A light, quick application of the iron to the skin is sufficient for scarring. Occasionally the branding iron may have to be reheated to its original cherry red color in order to penetrate to the skin. Burning the underfur also produces dense smoke that obscures the work area. Of 120 animals observed in 1978 which had been skin-branded with letter/number combinations in 1977, we saw no animals with inflamed wounds, though several of them had parts of the marks missing because the branding iron had not penetrated the underfur quite far enough.

It is important that the burning surface of the branding iron be curved in cross section, and have well-rounded edges. (We used round stock for fabricating our brands.) Sharp corners can burn quickly through the animal's skin to the flesh and leave long-lasting open wounds.

The location of pelage marks is important. Marks aligned over the animal's spine are the easiest to apply but can only be read from directly above, or if the animal lies on one side with its back directly to the observer. Such views are rare, so usually only part of the mark is seen. Marks on the flanks can be obscured by other animals. Two identical marks, one on each shoulder high enough that they almost touch at the mid-line of the back, are preferable. One mark or the other can usually be seen from any angle except when the animal lies on one side with its belly toward the observer. In this position its flipper tags can usually be read.

Whatever other marks are used, seals should also be given a spot (by clipping or branding) on the head. Guard hair should be removed in a circular patch 6-8 cm in diameter. In tightly packed groups of animals head marks are prominent and notify the observer to continue watching the animal until its mark or tag can be read. These marks have allowed us to identify a large number of animals that would never have been located by pelage marks or flipper tags alone. We now mark the heads of all animals we need to follow, regardless of what other types of marks or tags we may apply. Adult males are prominent enough without our applying head marks.

Harnesses

We use harnesses for attaching depth recording instruments to seals (Kooyman et al. 1976), for moving seals in captivity, and for securing special "chastity belts" to captive females during studies of estrus (Fig. 6). Harnesses are made of tubular nylon "rope" available in mountaineering stores. This rope lies flat like a double ribbon and is 2.5 cm wide. It is flexible and light, yet strong, it will not kink if rolled, and it is available in bright colors for easy visibility in the field. The harness has one strap around the neck small enough in diameter that it will not pass backward over the scapulae and front flippers, the point of greatest girth in otariids. It has a chest strap posterior to the front flippers which prevents the seal from backing out of the neck strap. The neck and chest straps are attached ventrally by two "belly" straps which prevent the harness from rotating around the seal's body, and by a dorsal midline "back" strap. Harnesses that carry instruments use a back strap made of stiff nylon belting material 5 cm wide. The neck and chest straps are adjusted to length by passing them through double "D" rings attached at the juncture of these

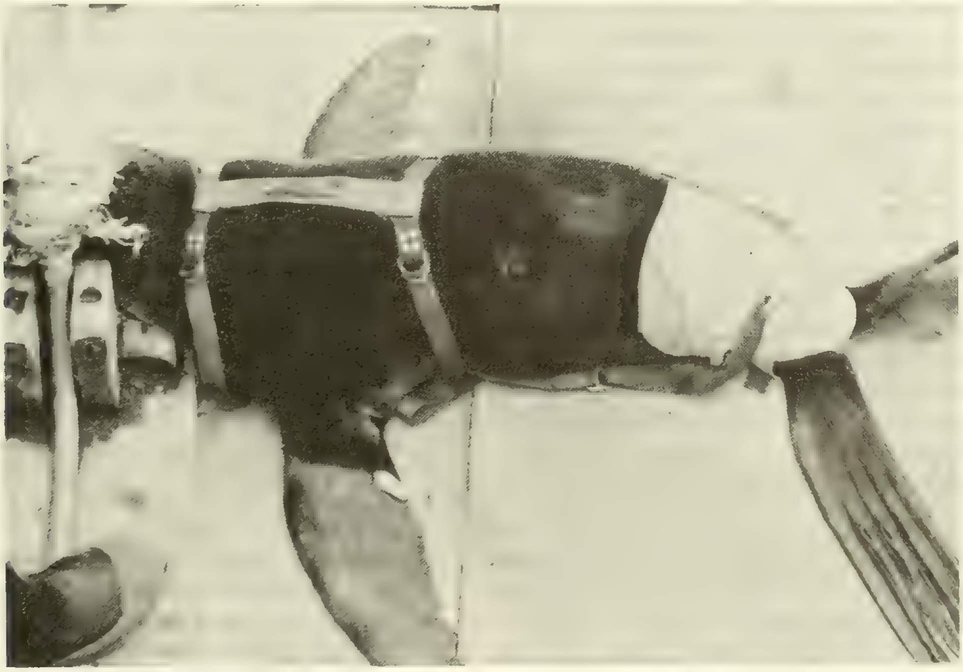

Figure 6.—A harness around the neck and chest of an adult female fur seal used to secure a "chastity belt" during experiments on estrus. The female is restrained by a hold-down bar.

straps with the back strap. The harness pieces are joined together with soft steel rivets so that if a released seal fails to return these rivets will soon rust, allowing the harness to fall apart.

Harness sizes and proportions vary, depending on the age and sex of the seal. The dimensions of a harness for a juvenile male seal weighing 65 kg (about 145 lb) are given in Figure 7. Note that the belly straps are longer than the back strap to accommodate the large chest muscles when the seal sits upright. No such accommodation is necessary in harnesses for females.

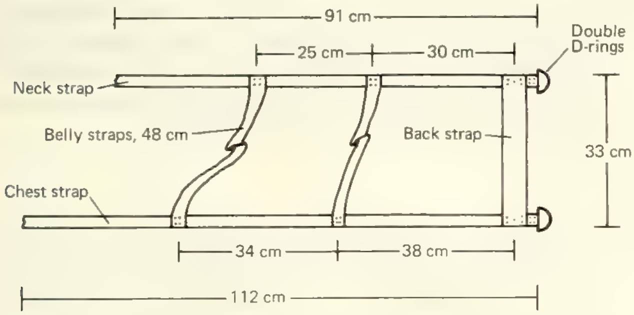

Figure 7.—The dimensions of a nylon harness used to attach a time-depth recorder to a 65 kg juvenile male fur seal.

CAPTURE TECHNIQUES

Adult Males

Teamwork is more important in capturing adult males than in any other kind of capture. One person should be responsible for determining which animals are to be captured, what efforts are needed to keep the captures running smoothly, and what steps are necessary to alleviate problems that arise (which rope to tighten, how to move an animal into a better position, what direction to pull, who on the work crew should move to another rope, etc.). The crew should be enthusiastic for the work to be done and have good rapport with the leader. Before marking begins the leader should demonstrate how to move around the animals, how to stop a charging male with a bamboo pole, and generally what to expect. He should stress the need for concerted group action, and the need for decisive individual action when someone is endangered. He should also stress that while there is no shame in running from a charging adult male fur seal, the worker who runs at the seal's first snort may abandon someone in a dangerous position and undermine the confidence of the rest of the crew. The leader must anticipate that some workers, when excitement is high, or when there has nearly been an accident, tend to vent their emotions through excessive roughness to the animals. Such persons are not allowed to work on our projects. In addition, we forewarn our workers that they may respond to stress in these ways, and that such actions are inappropriate and unacceptable.

Terrain is important to success in capturing adult territorial males. Most of our 155 successful captures have been made on a broad flat area measuring approximately 40 m by 100 m with a slight uphill slope at one end. The surface is hard-packed dirt or bedrock littered with fist- to man-size rocks. At another site, attempts to drag the animals up a narrow sloping beach of large boulders proved unsuccessful. The animals were able to wedge themselves behind the large rocks, and no amount of pulling would move them up the slope.

Marking may begin soon after males start arriving in May, and continue until the animals are too numerous to permit safe work, or until females begin arriving on the site. Optimum weather conditions for marking are heavy overcast, no precipitation, and a moderate wind. Rain makes both the ground and the animals slippery and treacherous, and bleach marks often do not "take" on wet fur. Work may be done on sunny days or warm days with no wind, but only with considerable caution: the animals are easily overheated.

The capture consists of getting two ropes (or lassoes) around the animal, and quickly dragging it to the marking box. Typical ropes are 1 cm (3/8 in) hemp 12-15 m long. At this time of year male fur seals are probably at their peak weight, and their necks are larger in diameter than their heads. A noose around the neck of an animal will merely slip off when the animal offers any resistance to being pulled. Nooses must go around the neck of the animal and behind one front flipper. When the two ropes are correctly applied each should pass over the animal's back, one going behind each front flipper, and crossing each other at the animal's chest (like bandoliers) (Fig.8) with the two ropes emerging from the loops close together at or below chest level.

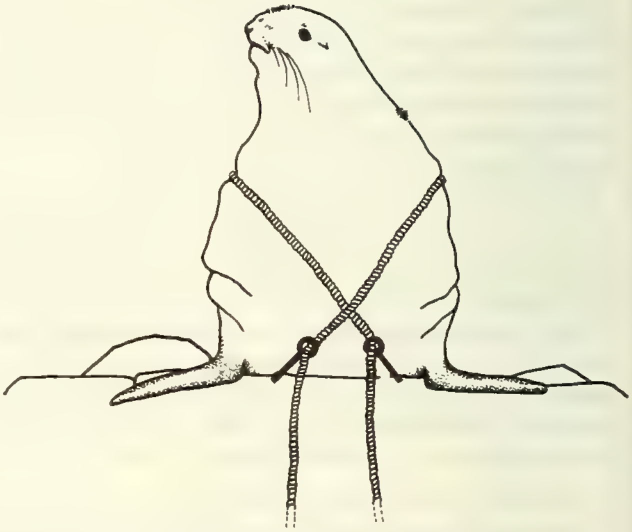

Figure 8.—An adult male fur seal showing the proper placement of two ropes across the chest used to drag the animal into a box for marking.

The animal should be approached by as few people as possible: one person manipulates the noose, one maintains tension on the rope, and one person assists in maneuvering the animal. A fourth person may stand ready with a bamboo pole a meter or so behind the working crew to provide assistance if needed. This small number of people seems to cause less disturbance, and the animals remain quieter and easier to work with than with larger crews. The lasso is hung on an 8 cm diameter hook at the end of a 4-5 m bamboo pole. The hook can be tightly strapped onto the pole with fiber tape about 5 cm back from the tip in the fashion of a boat hook. The lasso is not thrown because the flying rope frequently alarms the animal. The rope loop is dropped over the animal's head, and then arranged with the hook in such a position that the seal may step through it with one front flipper. By staring or approaching to within 2-3 m (ready to jump back quickly) one person can induce the seal to step forward into the loop, or to make a short charge or boundary display. At this instant the person controlling the end of the rope takes up the slack and pulls the noose tight in position across the seal's chest and behind one flipper. Some experimenting will show how best to position the rope to achieve this effect, and what sorts of noises or motions work best to stimulate the animals to move forward.

While the two ropes are being positioned it is important that the animal remain facing the marking crew and stand its ground. For this reason late May and early June are the best times for marking adult males. The animals are still sparsely distributed, and their territorial defense is strong. This is the time of year when males are most likely to continually face toward approaching humans and hold their ground rather than turning and running; they are most likely to make the lunges or boundary displays necessary for getting the rope loop behind the front flipper. Only when the animal is facing the direction it is being pulled can it be held successfully in the ropes. When the seal turns away the ropes are no longer hooked behind the front flippers, and the nooses simply slide back along the seal's tapering body.

To aid in positioning the rope the third member of the front rank working crew can stimulate the animal to move by judicious use of a bamboo pole. A light touch, or mild poke to the animal's hindquarters will generally cause it to move away from the stimulus; touching a front flipper with the pole will induce the seal to retract the flipper. These two tendencies are used appropriately to position the animal as desired. When inducing the seal to step through the lasso care must be taken to avoid touching the front flipper or the seal will retract it away from the rope loop and the procedure must be started anew. With the rope in place, and a worker maintaining tension on it, a fourth member may join the front party with the second rope, which is positioned similarly to the first.

Once the two ropes are properly positioned on the animal, other members of the work crew who have stayed 10-20 m back from the front rank may come forward and lay hold of the two ropes. The best procedure is for the six- to eight-person team to drag the animal to the box quickly (at a run if possible). Moving the seal slowly allows it to brace itself against rocks, to resist the movement, or slow movement may allow the animal to turn away and slip out of the nooses.

As the workers drag the seal toward the marking box, one of the two ropes is passed through the box and will be used to pull the animal into the box. As each worker on this pulling rope approaches the box, he releases the rope, runs around the outside of the box, and picks up the rope again on the other end. The second rope can be used to help control the path of the animal's slide toward the box. As the animal gets close to the box, only one or two people will be needed on this controlling rope; others may move to the pulling rope to help with the strenuous task of getting the animal into the box.

Just as the seal is reaching the box it is helpful to have one person leave the positioning rope, pick up a 2-3 m pole, and push the animal from the back side. The seal will offer considerable resistance to entering the box, hooking its flippers on the side, and forcing its head against the sides and top of the opening. The person with the pole can help by defeating the animal's holds on the box and allowing it to be dragged inside by the other workers. This person also has the clearest view of the seal's body entering the box, and is in the best position to shout the order to close the box doors.

One worker is designated from the beginning to be in charge of operating the doors to the box. This is an appropriate job for someone who is not a strong puller, or who is uncomfortable working close to the animals. As soon as the ropes are in position on the animal and the crew is ready to begin pulling, this person should be alerted to take position standing astride the top of the marking box. Once the seal is inside the box, the doors are dropped. The first door to be dropped is the one toward which the seal is being pulled (between the seal and the workers pulling it). Tension on the rope can be maintained by the pullers (holding the animal inside the box) while the rear door is dropped and the animal is contained.

An attentive person with a bamboo pole can stop all but the most concerted charge by a male fur seal. The most successful technique is a sharp jab or push with the end of the pole to the animal's chest or throat. A balance must be struck between very hard blows and accurate ones. The harder the pole is pushed, the less accurately it can be controlled. If a jab misses the seal and the animal moves closer, shorten the pole or step back and take another jab. Banging the charging seal on top of the head or batting it from the side will produce almost no effect whatever. If the animal is just beginning to move, a sharp blow to the side of the head may stop it, but this is risky because of the danger of destroying an eye or breaking a tooth. (The loss or breakage of a canine is a very harmful event for a territorial fur seal.) An animal that is not charging, but is generally too close to the work area or otherwise in the way, may be distracted by dangling the end of a pole just out of reach in front of and above its face. Soviet scientists move stationary males by lightly tapping them on the head with a bamboo pole that has been intentionally split into a dozen or more "ribbons" at the tip. These ribbons make noise but do not injure the seal.[3] Except very early or very late in the season it is nearly impossible to drive a single adult male out of its territory, even with the concerted efforts of several people with bamboo poles. Workers confronting a seal should stay familiar with who and what is behind them in the event that they may not be able to stop the charge, and must either run backward or turn and run. Special efforts should be made to avoid falling down on the rookery.

Subadult Males

Unlike the capture of adult males and adult females, which takes place on an individual basis, subadult males (2 to 5 yr old) are rounded up in small groups and held temporarily while individuals are pulled out and marked. These roundups usually occur on hauling out grounds adjacent to breeding areas. The most important factor in successful roundup, capture, and marking of subadult males is weather. These animals are very easily heat stressed. Careful attention must be paid to weather conditions and to physiological symptoms of the animals. Ideal weather conditions for working with subadult males are cool temperatures ($<10°C$), moderate winds, and overcast skies or light misting rain.

A roundup begins by two or more workers moving unnoticed into a position between the seals and the water. This may involve taking a long roundabout route, or some crawling on the ground to maintain a low profile. Remaining unseen during this first step is critical. Once in position below the particular group that is desired, the workers stand up, raise their arms or protective poles, and shout, whistle, or rattle noise makers. Once the seals begin to move inland, very little effort is required to keep them moving. In fact, the most attention must be paid to keeping the animals from moving too far or too fast. Some experimentation will show how much distance must be kept between the seals and the "herders" to move the animals an appropriate amount with the least amount of agitation.

Slow movement of the animals from one location to another cannot be overemphasized. Body heat builds quickly and is lost very slowly. The following symptoms indicate overheating: captive animals that lie prone rather than sitting erect, excessive rear flipper waving, animals which tilt their heads far back and pant with a rattle in their throats, animals which can move only a meter or so without falling prone to rest.

Once the animals are in position for holding and marking, minimal herding actions are required. One person or two can manage a small group (30 animals or fewer) without excessive agitation of the seals. A good strategy is to squat or kneel 5-10 m from the group and stand up or move into position to cut off their movements only when necessary. Cutting the animals off with the least disturbance involves making a wide circle around the group, to avoid causing them to run harder.

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[3] V. A. Vladimirov, VNIRO, Moscow, U.S.S.R., pers. commun. July 1981.

Portable fence sections can be used to erect a temporary open corral. Four or five partitions 1.25 m (4 ft) high and 2.5 m (8 ft) long are framed with standard construction lumber and covered with heavy-duty wire fencing material. An extra horizontal framing member about 0.5 m high receives the major stress of seals pushing against the fence. Corral sections are arranged with the wire fencing material to the inside to prevent animals from climbing on the horizontal brace. The fence sections are erected in an open U shape and tied together with rope. If marking or tagging operations take place about 5 m in front of the open end of the corral, the animals will stay inside with little attention from the workers and little agitation among the seals.

Seals held in close pods either by a corral or by a herder may lose body heat more slowly than normal. Close contact of their bodies and occasional crawling on top of one another can inhibit heat loss. For this reason the condition of the seals must be continually monitored even after they are enclosed and motionless.

Once the seals are rounded up and moved some distance inland, they may be captured individually for marking or tagging. The wire fence corral proves most effective for these individual captures, because a single worker can approach the group of seals and not require the assistance of two or more herders to prevent the group from moving away. Chokers 2.5 m long are used to snare individuals and pull them out of the group. (See section describing capture of adult females for choker techniques.)

Subadult male seals can be immobilized safely with a restraint bar. Various techniques for getting the animal into the restraint bar may be developed according to how many workers are present and how large the animals are. Although two people can manage the task, three are preferred. With two persons, one drags the seal using a choker, and the second grasps the seal's rear flippers. The seal is dragged sideways to the restraint bar. There the individual handling the choker holds the animal's head down with the neck across the yoke of the base plank while the second person releases the hind flippers and swings the bar into position.

In closing the bar, care must be taken to keep arms and elbows out of reach of the seal, and closure must be made quickly but judiciously to prevent the animal from biting the descending metal bar. This type of restraint device may have fabric padding wrapped around the metal bar at the U bend. This padding can prevent injury to the seal should it bite the bar, and also allows some adjustment in the size of the opening. With three persons available for restraining the animal, one may handle the choker, one holds the animal's rear flippers, and the third person can manipulate the restraint bar.

Even while in a restraint bar, seals can show considerable strength in lifting themselves off the ground with their front flippers. An animal struggling in the bar can best be restrained and quieted by pulling its front flippers back and folding them under the body. This can easily be accomplished by a person straddling the seal in the kneeling position. This straddled position is convenient for applying tags and marks, clipping heads, installing harnesses, or simply restraining the animal until it stops struggling. Even while restrained in the bar the animal has a surprising reach with its neck. Be watchful of arms and elbows in the vicinity.

There is some danger of asphyxiating an animal in the restraint bar. With careful observation however, this danger can be reduced to a minimum. A number of symptoms give advance indication that an animal is suffering undue stress: 1) breath rate—it is sometimes difficult to determine whether the animal is voluntarily holding its breath, or is being prevented from breathing by the restraint bar or choker. With a finger sharply jab the seal in the ribs; breathing will resume if the breathhold is voluntary. 2) Breath sounds—normal breathing may be quite noisy even when the animal is getting adequate air, and the inspiration may be short. However, if the inspiration is very labored and terminated by the jaws audibly snapping shut, the animal's trachea is probably compressed, and the pressure on the restraint bar should be eased. 3) Tongue color—the tongue is a fast indicator of the animal's condition. If the tongue begins to turn blue, the animal is short of air; the bar should be eased and the animal encouraged to breathe deeply for several seconds. 4) Eyelid twitching—rapid twitching of the eyelid is another indication of interrupted air supply. All four of these symptoms are indicative of more serious problems to follow within a few seconds if the animal's situation is not changed quickly. 5) Convulsions—violent convulsive quivering immediately precedes unconsciousness. When an animal begins to convulse, pressure on the bar must be removed immediately. (For this reason it is important to keep the choker loosely around the animal's neck even when it is being restrained in the bar.) With the bar released (and one person standing by ready to tighten the choker) a sharp blow with the fist or heel of the hand high on the animal's back, or a vigorous shake of the animal's hind flippers is adequate to bring the animal back to consciousness and restart the breathing. Speed and decisive action are essential if the animal is to be spared.

The person handling the restraint bar has the best visibility and should carry the responsibility for observing the animal's condition, but all workers should be aware of the animal and watch for symptoms of stress. When a large number of animals is to be marked, handling the restraint bar can be a tedious job, yet it requires a high level of attentiveness. Safety of the animal and the persons working around it are at stake. This job should be rotated among workers at the site, or the one person with the job should be given considerable encouragement to remain alert.

Peripheral Males

Male fur seals approaching adult size (5-7 yr old, 100-160 kg) can be caught and marked using a hoop net. They are not immobilized, but since their vision is restricted by the specially constructed net, they struggle relatively little. Males of this size can be found moving about on the periphery of the rookery (hence their name); they are also called "idle bulls." These males are beginning to acquire the final adult "shape," but are not as broad across the chest as are fully adult males.

Capturing peripheral males is very active work because they are not yet defending a territory and, hence, will not stand their ground. Rather, they tend to run into the nearest rookery, or through a rookery to reach the water, which can cause considerable disturbance. Prior to a capture attempt, the animals should be driven inland, either individually or in small groups, some distance away from the rookery edge. This allows some operating room for the captures and reduces the disturbance to the rookery caused by humans moving about. It is also easier to control the movements of animals once they are some distance inland. A peripheral male making a vigorous effort to escape into a rookery or into the water is virtually impossible to stop with a bamboo pole.

This type of capture requires only a hoop net 0.75 m in diameter and 2 m deep (described above), three or four workers, and at least two stout bamboo poles 3-4 m long. The longer poles for capturing territorial males are rather cumbersome for cutting out one of these large animals from a group. Whatever marking or tagging equipment is selected for this animal should be carried in a bag or bucket because the final location where the animal will be immobilized is difficult to predict.

Two persons cut out an appropriate male from the group that has been driven away from the water, or cut off a single individual from its escape route. A third person handles the net. In some cases a fourth person may be required to control a pod of large animals that has been driven inland to prevent them from scattering while the individual capture is taking place.

In this technique the ultimate objective is to get the hoop over the animal's head and all the way to the ground with the animal's head inside the bag in the deep end of the net and then to have the animal step over the hoop and into the net with at least one of its front flippers. Since a running animal will be less aware of the net in the air over its head and will be less likely to bite the hoop as it descends, it is best to induce the animal to run away from the net handler before the capture attempt. A running animal can sometimes be properly netted in a single stroke. Avoid netting stationary animals. Males isolated at a safe working distance from other seals will remain stationary, facing their captors, unless goaded into running. Stationary animals can bite the hoop and break their canine teeth. They can also shake their head and neck vigorously to dislodge the hoop. Stationary males can be made to run by a series of jabs to the ribs or flanks with a pole.

Once the hoop is over the animal's head a second effort is frequently required to drive the animal entirely into the net and complete the capture. For this step of getting the animal into the net, the net handler should be behind the animal. Maintaining this position may require running around the animal while holding onto the handle of the hoop since netted seals tend to spin. The other two members of the party must try to stay out of the net handler's way in this exercise. A bamboo pole can be used to lift the net and bag into the air over the head of the animal while the hoop is forced to the ground so that the bag drops over the seal's head.

One final step is important to prevent the seal from backing out of the net. The animal should step forward over the hoop, so that it is standing with at least one and preferably both flippers on the metal hoop, or on the net outside the hoop. Once this is accomplished the animal will be holding the net stationary with its own weight. If the seal will not voluntarily step forward, have one worker grasp both rear flippers and pull backward (out of the net). Seals resist this pull by obligingly stepping forward. To secure the net, the rear flippers are tucked inside the hoop, and the net handler stands atop the junction of the loop and the handle.

Although the animal will be noticeable quieter with its head in the bag, the net allows considerable freedom of movement of the seal's head and upper body. Precautions must be taken to prevent workers from being bitten through the bag. Two persons work on opposite sides of the animal from the rear angle. One reaches across the back of the animal, forces a bamboo pole into the ground just forward of the front flipper, and holds it vertically between the seal's head and the third person, who attaches tags to the front flipper (see Fig. 9). It is also possible to help control the animal by grasping the mesh of the net low down on the animal's back and pulling the seal off balance sideways.

Tags may be applied through the mesh of the net. The person applying the tag must be conscious of maintaining good balance, and of not becoming entangled in the net, since netted animals can still lunge dangerously. It is easy to become involved in the concentration of getting tagging pliers into the proper position or to become frustrated with a difficult animal. This can lead to dangerous situations.

The animal is released by lifting the net up and moving it forward, allowing the seal to back out. If the animal becomes tangled in the net during capture the purse string at the end of the net can be cut to release the animal through the deep end of the net. The animals are generally disoriented for several seconds after release. Nevertheless, one person with a bamboo pole should stand by to protect the net handler. Avoid snaring the tags in the mesh, since they may be pulled out of the flippers as the net is being removed.

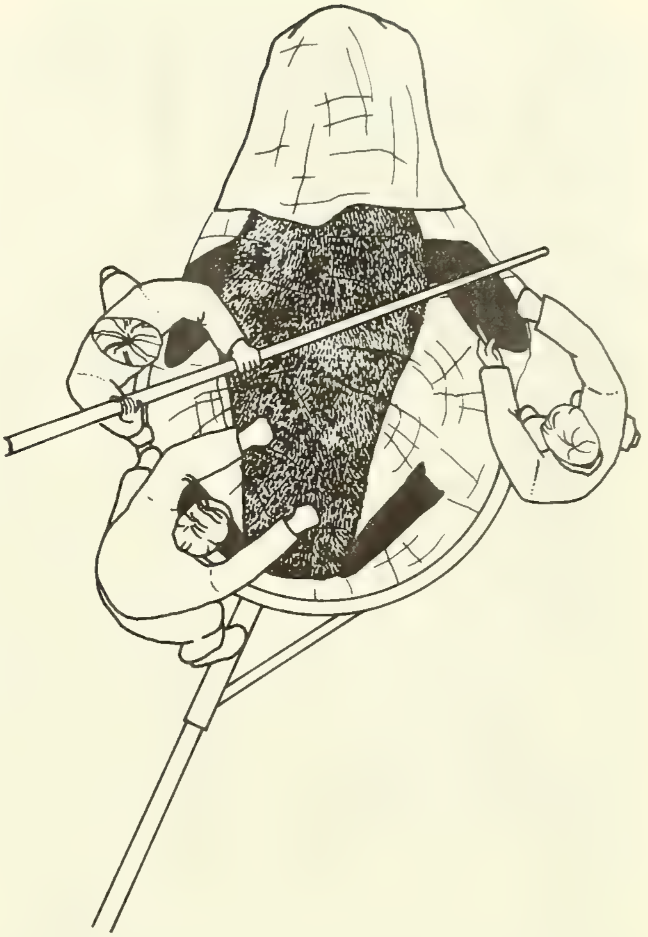

Figure 9.—A method of capturing male fur seals weighing up to 160 kg using a hoop net. The seal's vision is obscured by a bag sewn into the deep end of the net. One worker stands on the handle of the net and keeps the seal off balance by pulling on the net. A second person holds a pole between the seal's head and front flipper to protect a third worker, here applying a tag, from being bitten.

Adult Females

Each capture situation with females is unique, depending on the time of year, type and number of females desired, the stage of the reproductive cycle, and the amount of disturbance the worker is willing to create. The procedures described here have evolved over several years of catching animals. Although certain of the precautions should not be violated, successful captures frequently depend on the worker's ability to be inventive or to make fast decisions in the midst of the situation.

1) Noose captures.—At the right time of year adult females can be captured individually with relatively little disturbance to the rookery. The basic technique consists of locating and ensnaring a newborn pup whose mother is identifiable, holding the pup until the mother can be ensnared with a long choker, and then pulling the two out of the rookery.

Captures employing this technique have been made in the Pribilof Islands from about 20 June to 15 July. Later captures are possible, but after mid-July new births are very infrequent and do not commonly occur on the inland edges of the rookery as they do earlier in the season. Mothers with newborn pups are preferable for several reasons: 1) the mother/pup bond appears to be strongest 1 to 3 d after parturition. In this period mothers are least likely to run to the water as humans approach, or to abandon their pups upon being released after the capture. 2) Strong pup attachments occur almost simultaneously among the female population because of close synchrony in the timing of births. Therefore the entire rookery is less sensitive to human presence when newborns are available. 3) Newborn pups offer little resistance to capture. 4) Mother and newborn pup are usually physically close to each other so that pairs are easy to recognize. 5) The date of parturition is known if needed.

Equipment for this type of capture consists of one bamboo pole 3 to 4 m long for defense against males, one 5 m long choker of fir for the female, and one 5 m long choker of bamboo and light cord for the pup. Transport boxes, hold-down bars, or marking equipment are used as appropriate, but these are left at some distance back from the edge of the rookery.

The keys to a successful approach are moving slowly and maintaining a low profile. Voices must be kept low, and equipment not allowed to bang or rattle on the rocks. Keep all equipment low to the ground or disturbances will result. Only two persons are needed for this type of capture, and they should approach the back edge of the rookery carefully. Within 10 m of the closest females they sit down and continue moving on hands and feet (spider fashion), sitting between moves. If there are many threatening males, move on hands and knees, or "duck-walk" in preparation for defense against males.

Patience during the approach phase of the capture is often rewarding. We typically spend more time approaching and waiting for the female to make a favorable move than at any other part of the capture routine. A few minutes spent in an uncomfortable position on the rocks surrounded by large males causes apprehension, but waiting is preferable to hurrying the capture, or making a frantic lunge which can defeat the entire effort or cause a major disturbance.

Selecting the pair to be captured is more difficult than it sounds. New pups are best identified by the condition of the placenta; it will remain bright red and bloody for 24 h. The umbilicus remains pink and wet-looking for 48 h. Mere presence of a placenta does not indicate new births since a dry, black placenta may be dragged about for 6 or 7 d. Age is more difficult to identify in the rain since the umbilicus remains clean and wet looking longer than on a dry rookery. Sometimes the pup must be noosed and turned onto its back with a choker before the condition of the umbilicus can be seen. The mother's reluctance to leave a pup is a good but imperfect indicator that the pup is new. Some solicitous females remain with their pups for 6 or 7 d after birth. Regardless of the age of the pup, do not attempt to capture females that abandon their pups and flee; fleeing females cause a great disturbance. Once the pair is selected for capture the workers should keep close watch on both members of the pair to avoid capturing the wrong partners.

The pup should be noosed first before the mother moves it. The lightweight noose is dropped over the pup's head and the pole is rotated until the rope is tight. Whenever a choker is used, raise it in the air just high enough to clear the animal's head; a waving choker alarms all the animals. Do not stand up while placing the choker; place it from a sitting, kneeling, or squatting position. Always move the choker slowly, and do not make rapid thrusts at an escaping animal. When the pup choker is loosely in place the pole may be placed on the ground and the pup ignored until the mother is noosed.

The technique used to noose the mother depends on her behavioral tendencies. The easiest case is when the female is relatively fearless and is on the edge of the group of animals. In this situation let the choker lie on the ground beside the female. When she turns her head away from the choker, lift it just enough to drop the loop over her head from behind and tighten by twisting the choker pole. The rope should not be allowed to wrap around the pole as it is twisted, but should form a twist off the end of the pole just under the chin (Fig. 10). Since the seal's head is narrower than its neck the loop must be twisted very tight—so tight that a fold of fur is caught in the twisted rope. Work quickly but without sudden jerks that alarm the female. Give the choker a trial pull to observe whether it is tight enough.

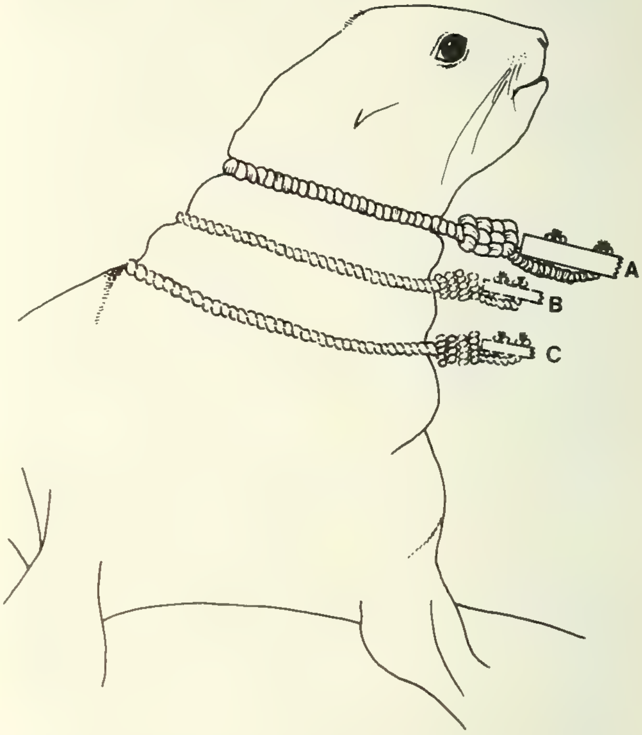

Figure 10.—Illustration showing the placement of a choker (A) too high on the neck, (B) correctly, and (C) too low. The same placement is appropriate for both juvenile males (shown here) and for females.

If the female is wary and ducks away from being noosed other measures are required. First, slowly draw the pup away from the female a meter or so. If the pup is moved too far from the mother she may not come out of the group to retrieve it. If the pup is not moved far enough she may seize it in her teeth and start back with it before the noose can be placed over her head. This can result in an unwanted tug-of-war with the pup in the center. If this occurs allow as much slack on the choker as possible and induce the female to release her hold on the pup. As an alternative to drawing the pup out, agitate it by moving it forward and back, or side to side using the choker. Moving the pup, or drawing it out keeps the female's attention on the pup and away from the workers or the choker. Drawing the female out, if it works, also reduces the disturbance to other females.

If a female is wary of the choker and will not follow her pup out of the group, move the pup close to the mother and lay the open loop of the female's choker on the pup's back. Then when the female touches the pup's back with her nose, which they often do, lift the loop over her head.

Once the female is caught in the noose she should be removed with all possible speed. Both workers stand for the first time and, with a hard pull that brings the female forward onto her belly, they run several meters. Running bent over causes less disturbance. When the female is 4 to 5 m from the group one worker drops behind and grasps one or both rear flippers. The female may then be half dragged, half carried either with the workers in tandem or side by side. Running removes the female from the male's presence as quickly as possible, shortens the time the female lacks air, and prevents the female from resisting being moved. The lead worker should be aware that this is simultaneously the moment of greatest stress and the moment when the most important decisions are to be made; he should try to remain calm despite the exertion.

While dragging the female carefully watch her condition. If the noose is tight enough to prevent her backing out it may also close her trachea. If the female begins to convulse release the rear flippers and loosen the choker immediately. There is little danger of the animal escaping during this procedure. The symptoms and response to asphyxia were given in the section on handling subadult males. Remove the female from the sight of other females as quickly as possible.

After the female is immobilized in the restraint bar, or placed in the transport cage a single worker returns to retrieve the pup. Special attention must be given to moving pups with attached placentas. These animals must be lifted carefully over rocks or sharp obstructions; even a moderate pull on an attached placenta may eviscerate the pup. To carry a pup with an attached placenta grasp the umbilicus close to the placenta in the same hand that holds the rear flippers. If it is decided to remove the placenta tie off the umbilicus with a piece of string a few centimeters from the belly and cut distal to the string to prevent bleeding.

To be certain that the correct pup has been captured for a given female place the two captives close together. A vigorous vocal exchange will indicate that the two are a pair; the female will repeatedly nip any pup but her own. Occasionally a female will even bite her own pup inside the transport cage. Remove these pups to prevent injury.

Pregnant females too can be captured by noose but these are the most difficult and dangerous of all captures. Pregnant females usually flee at the first sight of a choker unless the approach is made from the water's edge working uphill. From that position they are almost as easy to noose as any other female. But working between breeding seals and the water leaves no room to maneuver away from charging males, and the footing in tidepools is difficult. Also, an extra helper is needed to watch for new males arriving from sea during the disturbance. Pregnant females, being heavy, cannot be dragged away from the males as quickly as nonpregnant ones, and may be bitten as they are pulled out. These captures should not be attempted unless the acquisition of pregnant animals is mandatory; when captives are required we recommend post parturient females. These captures should never be attempted by inexperienced workers.

The problem of greatest concern in capturing females, especially in captures with a noose, is the adult territorial males on the rookery. The greatest danger from these animals is misreading their signals or reacting slowly to their threats. One must not be intimidated by their appearance or by the mental image created by the name "bull seal." These animals have many behavioral characteristics that can be employed against them by a clever worker. Admittedly there are a few males whose aggressiveness and tenacity cannot be dealt with using any combination of tricks. The wise worker identifies these seals and simply works elsewhere.

Adult males attend to the workers as soon as they are visible on the rookery. Their vocalizations alert all animals to the workers' presence. As soon as the workers have crawled up to the edge of the male's territory the seal will charge. Usually the first charge is the longest and most determined. From the squat position deliver a powerful jab to the seal's chest and throat area using the short bamboo pole. Usually one or two jabs will stop the charge. The second worker with another pole should be positioned behind the first so that if the charge does not stop, the lead worker can run while being protected. Deliver as few jabs as necessary since swift motions disturb the females. Do not stare directly at territorial males since this induces them to charge. Instead face obliquely and glance at them occasionally. Lying prone on the ground also reduces the frequency of male charges, although it heightens the sense of vulnerability. After two or three charges the male will usually rejoin the females. A perceptive worker can anticipate each charge since males usually draw a deep breath while looking obliquely at their target just before they rush. If the workers make daily appearances on the rookery to capture females the initial charges will become fewer and less determined.

Males most often interfere with the capture by blocking the target female from being noosed or removed. With persistent males, tap them lightly on the rear flippers or in the ano-genital area, or tap them lightly in the ribs or on top of the head with a choker. Some males will avoid these mild irritations by moving away. Frequently an overly attentive male (or an aggressive one) can be diverted by tossing over its head small rocks which fall into the rocks on the opposite side of the female group. The small clatter of these stones will mildly disturb the females, and the male may rush to block their exit. The male's attendance on the opposite side of the female group aids captures by keeping the females stationary. Bothersome males can also be diverted by arousing adjacent males. Pebbles cast at neighboring males causes them to vocalize, herd their females, or give a boundary display at the subject male which effectively reduces attention to the workers.

While the noosed female is being dragged from the rookery, the male may chase her for 10 m or more. The male's chase is the main reason the female should be removed while running. If the male catches the female he may deliver a wound to her back, or may seize her in his teeth so that a tug-of-war ensues. The best tactic is to stop moving the female just before the male reaches her. Use the short bamboo pole to drive off the male if possible. Do not pull on the female being held by a male; allow the male to carry her back to the group and try to divert the male as above.

Other males may approach from the sides or from the back if the capture has taken a long time. Use a third worker to keep the path of approach open at all times if there are so many males that such closure is likely. After the female has been removed from the rookery proper the danger from males is not over. Peripheral males will be attracted from 50 m or more by the sight of a female above the rookery. These males show more attentiveness to the female than aggressiveness toward humans. Although they can be driven away easily the danger from these animals should not be minimized

2) Net captures.—If females are to be captured later than the last week of July a hoop net must be used since at this time of year females will not remain stationary long enough to noose them. Catching with a net causes more disturbance than catching with a noose, and since an animal is relatively less restrained with a net than with a noose, the animal is more dangerous to the workers. However, this type of capture requires less experience to succeed than do other types of captures.

The equipment necessary for this type of capture is a hoop net 0.75 m in diameter, having a 1.5 m deep net with 10 cm mesh, and a handle 4 m long made of aluminum tubing. The hoop should be wrapped with cloth or rubber to reduce noise when hitting rocks. Captures using a net depend on stalking a sleeping seal until the workers are within 5 to 6 m, and then making a sudden, short dash to the animal.

The workers must approach slowly, remain hidden at all times, and make no noise. The approach phase of such a capture is often more prolonged than with a noose capture. Do not try to outrun seals over large boulders while holding a net. Furthermore, stalk a specific seal; do not alarm a group hoping to make an instant choice during the chase. If the target seal is in the center of a group, the seals at the edge of the group can be moved out of the way by tossing pebbles onto the rocks near them and making sudden hand and arm movements that only they can see.

Try to net from directly behind a fleeing seal, placing the hoop over the head and neck so that the seal steps over the front edge of the hoop into the net. Then lay the hoop flat on the ground and stand on the ring. The head can be held immobile with a hold-down fork, or by grasping large folds of skin just behind each ear using bare hands. To transfer a netted seal to a cage or restraint bar, first place a choker on the seal while it is still under the net. Adult males are not a factor in this type of capture since they either are not present or are not territorial after 1 August. No bamboo poles are needed for defense against males here.

3) Mass captures.—It is possible to capture 50 to 100 females in a group after the first of August. These captures obviously cause great disturbance to the rookery, so they must be well justified. The principle is that a group of females and pups is cut off from escape to the sea by workers holding moveable fences. By advancing the fences away from the water the seals can be removed from the rookery to flat ground where the fences can be formed into a corral. From the corral females can be handled individually with a choker. We have made mass captures while adult males are on territory. However, this procedure is exceedingly dangerous and should not be attempted by inexperienced handlers.

At least six workers holding three sections of fence between them are required. These fence sections may be similar to those described for use with subadult males. The workers move the fences as close to the back of the rookery as possible without detection. Two teams station themselves together at least 25 m from the third single team. At a signal, the teams dash forward holding the fence between themselves and the seals and attempt to form a U-shaped enclosure on the seaward side of the seals with the open arms of the U facing inland. Surprise and speed are essential. The females will quickly collect against this fence in a pile and must be forced to move away from the water by prodding them through the fence with bamboo poles, by shaking noise makers, and by physically pushing them with the fence. Females in a mass are very difficult to drive in a desired direction. However, it is imperative that they be moved immediately; otherwise, pups are likely to be killed by suffocation. Once females are moving they must not be allowed to stop because they are difficult to start again. When the animals are in the desired location for further handling a fourth fence section is added and tied with ropes to complete the corral.

Pup Captures

Individual pups may be captured during the first 2 or 3 d postpartum using the method described under noose captures for females. Later in the season pups may be captured independently of their mothers as they wander the peripheral areas of the rookery. The area covered by wandering 2-mo-old pups is considerable, and the chances of any given pup being on the inland border of the rookery at some time during the day are good. These animals are also captured with a long bamboo pole with a noose of light cord on the end. Sleeping pups are by far the easiest to capture. A pup running to escape capture can move down into the rookery faster than can a person carrying a long pole and who is trying to avoid causing a disturbance. Late in the season when disturbance is less important a small long-handled hoop net may be used for capturing pups.

When the rookery structure has largely broken down late in the season, large numbers of pups may be rounded up with portable fences in a manner similar to that used for subadult males, or for mass captures of females. Adult males and females on the rookery at this time of year can be driven off quite easily. To minimize the number of pups escaping into the water, plan carefully before the roundup begins. Two persons can handle a roundup and marking operation.

Pups up to 2-3 mo of age can be safely held up in the air by their hind flippers at arm's length. For longer trips place the free hand under the animal's chest, but still with arms outstretched. Pups have a surprisingly long reach, and if carried close to the chest can severely bite a person's shoulders, upper arms, or face.

Heavy gloves are required. Teams that mark large numbers (thousands) of pups extend their protection to the shoulder using a sleeve cut from a leather jacket. While marking 25 or more animals, minor nips are almost inevitable.

Short poles (1.5 to 2 m) are useful for herding groups of pups. Rigid sections of low fencing (1.5 m high) can be arranged in a U-shaped corral to hold groups of up to 25-30 pups. Inside these corrals the pups will crawl atop one another. This may allow some to escape over the top of the fence, and may cause some to suffocate at the bottom of the pile during the roundup. The animals should be driven back from the fence, or physically pulled off the top of the pile at frequent intervals. In extreme cases, lift the fence up and let the pups go toward the water

During the peak of pupping, northern fur seals will not flee from humans moving over their heads. For years wooden walkways (catwalks), elevated 2.5 to 3 m off the ground, have given researchers access to the centers of breeding groups to census, photograph, or collect animals for autopsy (Keyes 1965). We have recently used them as a platform to capture live pups for sexing, tagging, and growth studies.

Captures are made using a bamboo choker about 4 m long. From the squat position on the catwalk (to reduce alarm among females) lower the noose of the choker straight down. If the cord is so limp that the noose will collapse in this position stiffen the cord by wrapping tape around it. Using the end of the choker to move the pup around, arrange the noose so that it includes the pup's neck and one front flipper, and tighten by twisting. This placement of the noose encircles part of the rib cage and prevents closure of the trachea when the pup is lifted off the ground. With hand-under-hand motions lift the pup straight off the ground. This must be done very quickly to get the pup (and possibly its dangling placenta) out of the mother's reach before she can bite it. Quickly place the pup on the catwalk or have a second person catch it; dangling pups unwind the chokers and may fall.

Adult males often interfere with captures from a catwalk. Some will aggressively chase the choker and prevent the pup from being noosed. These animals can be distracted with a second choker, or by tossing pebbles as described in the section on female captures. Very few males will bite and toss dangling pups; simply avoid working near such males.

To minimize disturbance, capture only pups that are directly beneath the catwalk. If pups are noosed at some distance away from the catwalk (2-3 m), they cannot be lifted from there but must first be dragged beneath the catwalk. Mothers will chase pups that are dragged away, and the resident males will often chase the females. Great injury and disturbance can result from these chases. By the end of July or the first of August both females and pups are too wary of humans to permit further captures from a catwalk.

FEEDING OF CAPTIVE ANIMALS IN PERMANENT FACILITIES

Holding and feeding captive fur seals requires a considerable investment in time (particularly in the early stages), and usually results in less than 100% success with all animals. In planning for our needs for captives, we generally anticipate that 20 to 25% of those animals brought in will not learn to eat in captivity and will have to be released. Adult females should not be held longer than 8 or 9 d without food. Other researchers have also noted that some northern fur seals are slow to begin feeding in captivity (Bigg et al. 1977; Spotte 1980).

We keep herring and squid frozen at 0°F or below until the day of use. Protein breakdown in the thawed fish appears to be rapid which may decrease the nutritional value and reduces the acceptability of the food. No fish is kept frozen more than 1 yr. Although we have made no attempts to find out what the maximum consumption would be, we have found that females fed 5-7 kg of whole fish per day do not appreciably lose weight over a period of a month to 6 wk. Diet is supplemented by vitamin tablets ("Sea-tabs") specifically formulated for marine mammals. These tablets are inserted into the body cavity of a herring before it is fed to the seals. Because seals may pass the first food of the day through their systems quickly, (Kooyman[4]) we introduce the vitamin-supplemented fish sometime near the middle of the feeding session. Seals may not eat all the fish given in a feeding session and hence may miss a vitamin dose given late in the session.

During the first few days of captivity the animals are particularly sensitive to the presence and movement of nearby humans. To avoid this distraction, we generally try to stay out of sight of the animals during the first few feeding sessions. Our animals are trained to take dead fish while swimming. Animals are allowed into the feeding tanks and are given a few minutes to acclimate to the new surroundings. Then from a position out of sight (in the rafters above the tanks) fish are dropped one at a time into the water close to the swimming seals. For the first few sessions, interest in the food shown by the seals appears to be little more than curiosity. They may take the fish into their mouths, but generally do not eat. Occasionally a seal hauled out on a resting platform above the water may enter the water to investigate a fish dropped in the water nearby, but more typically this happens after the animals have learned to eat the dead fish.

The animals do not learn to accept dead fish at the same rate. At times it may prove valuable to experiment with putting a noneating seal in the same tank with a seal which has learned to feed (see also Spotte 1980). The amount of aggression displayed by different seals may vary widely. Once all the animals are eating, it may be necessary to keep more aggressive animals separate from less aggressive ones to more evenly distribute the food.

The amount of fish eaten and the portion of the fish consumed varies from day to day and among different seals. Sometimes only fish bodies are eaten; heads are bitten off and discarded. Occasionally seals will tear open the fish and consume only the livers. Most frequently we have seen animals eat entire fish for the first two or three offered on a given day, then begin biting off the heads and eating only the bodies. (This should be considered when fish are supplemented with vitamin tablets.) Seals usually begin by taking only one or two fish in the first feeding session. Good feeders rapidly increase to 3 or 4 kg per day in two or three sessions. Some appear to be insatiable, but if fed to satiation they will develop diarrhea and stop eating. It is best to increase the amount of food by a modest amount each day when a seal begins feeding.

Once the animals have begun to accept dead fish, the feeder may begin throwing fish into the tanks from a visible position. Eventually seals can be encouraged to eat at the near edge of the tank, and some will finally learn to take fish directly from he feeder's hand. The value of this training (especially if more than one seal is fed in a tank at one time) is that the amount of fish consumed by each animal can be monitored more accurately.

The degree of success with inducing seals to feed, and the amount of continued successful feeding may depend upon stresses placed upon the animals between feeding times. We recommend that the animals be disturbed as little as possible between feeding sessions for the first several days while they are still learning to accept dead fish in captivity.

One- and 2-yr-old subadult male seals have also been held in captivity and have learned to feed on dead fish. For experimental purposes these young males were taught to take fish while out of the water. This is not recommended as a normal procedure for feeding since animals choke on the loose scales.

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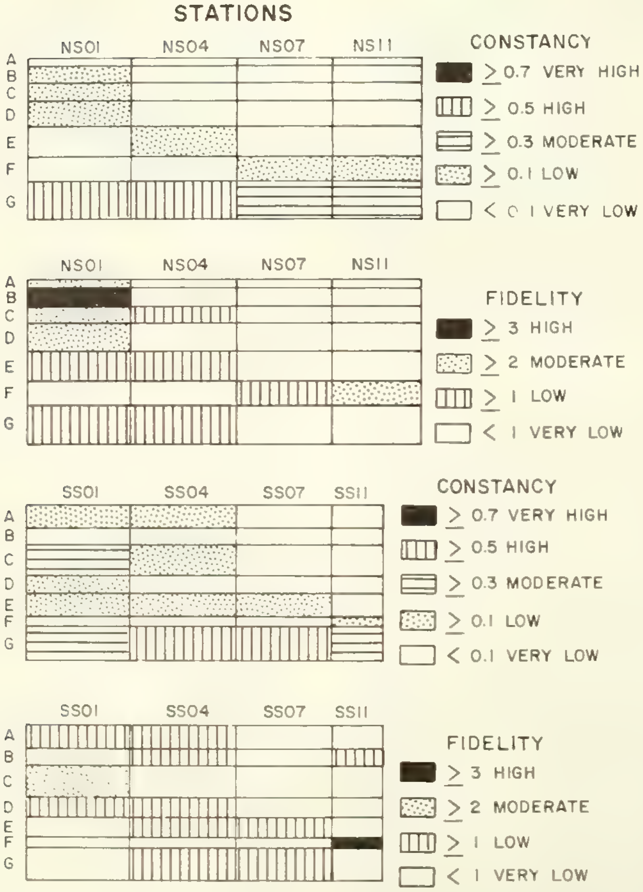

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Catch Temperatures for Some Important Marine Species off California

James L. Squire, Jr.

August 1982

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Catch Temperatures for Some Important Marine Species off California

JAMES L. SQUIRE, JR.[1]

ABSTRACT

Airborne sea surface temperature surveys using infrared techniques were conducted monthly off the central and southern California coast, 1963 through 1968, by the National Marine Fisheries Service in cooperation with the U.S. Coast Guard. The resulting temperature data were matched to commercial sportfishing boat catch data to determine the relationship between catch and temperature for the following major sport species: chinook and silver salmon, *Oncorhynchus tshawytscha* and *O. kisutch*; yellowtail, *Seriola dorsalis*; Pacific bonito, *Sarda chiliensis*; Pacific barracuda, *Sphyraena argentea*; white seabass, *Atractoscion nobilis*; and albacore, *Thunnus alalunga*.

Part I presents graphs for each of the above species for areas having high catches, the month during which most fish were caught, sea surface temperature at which most fish were caught, mean catch temperature and its standard deviation, and temperature range.

Part II describes how catch and catch-per-unit-effort (CPUE) are related to temperature. A series of weekly airborne temperature surveys were flown over a high catch rate area off San Diego, Calif., April through October, in 1972, 1973, and 1974. These temperature data were compared with catches of yellowtail, Pacific barracuda, and Pacific bonito by the sportfishing fleet within the survey area. Graphical Kolmogorov-Smirnov cumulative preference curves of catch versus temperature for yellowtail, Pacific barracuda, and Pacific bonito show increased catch rates through the midrange temperatures 17.8° to 20.0°C (64° to 68°F) with a reduction in rates above 20.5°C (69°F).

For a 31-wk period starting on 1 April 1972, 1973, and 1974, the temperature at the 20th percentile of the catch temperature curve was slightly above the 20th percentile of the cumulative temperature curve, indicating that fewer fish were taken at the very lowest temperatures; otherwise, catch for the three species appears representative of the temperature distribution. The average yearly temperature for large catches of Pacific barracuda, yellowtail, and Pacific bonito (30% or more above mean) fluctuated from 16.2°C (61.2°F) to 23.0°C (73.5°F), with a mean value of 19.5°C (67.1°F) for Pacific barracuda, 18.5°C (65.4°F) for yellowtail, and 19.6°C (67.4°F) for Pacific bonito. Nonparametric rank correlation tests (Spearman and Kendall) for catch and CPUE versus temperature showed consistently higher correlations for catch than for CPUE, indicating an increase in effort with increasing catch. In analyses of temperature and CPUE by species and year for 12-, 17-, and 31-wk periods, about one-half of the individual cases tested were, on the average, statistically significant at the .05 level.

Temperature distributions within 20th percentile ranges of the cumulative CPUE curves obtained for the three species combined indicate that the lowest temperature range, 12.7° to 15.5°C (55° to 60°F), is the only area where catch rates were lower than expected.

There is little evidence for a preferred temperature within the range of 15.5° to 21.1°C (60° to 70°F). Conclusions from this study indicate that fishery data are by no means optimal for examining the hypothesis of preferred temperature, due to confounding of cause and effect between catch and effort. Lack of simultaneous observation of the spatial distribution of species and environmental measurements over the extent of distribution over time are limiting factors in determining the true relationship of species to the environmental factor of sea surface temperature.

INTRODUCTION

Normal and anomalous changes in the ocean environment, as measured by sea surface temperature (hereafter referred to as "temperature"), produce a variety of effects upon the apparent abundance and geographical distribution of coastal and oceanic pelagic marine species. The coastal marine environment consists of biological, chemical, and physical factors which may independently, or in combination, influence the abundance and distribution of fishery resources. Although temperature is a commonly observed environmental variable, only limited statistical information is available comparing the catch of fish in waters of different temperature. A recent comparative temperature study in the northeast Pacific was prepared by Radovich (1975).

Development of management programs for coastal pelagic fisheries requires knowledge of the distribution of pelagic species, with regard to natural fluctuations in the physical marine environment. It may be possible to use environmental information to improve estimates of population size and distribution, and to evaluate the effect of environmental changes on catch. However, in order to apply fully effective resource management, we must learn more about how coastal species respond to changes in their environment.

Temperature is one physical variable which is relatively easy to measure. The ocean's surface layer temperature reflects the exchange of thermal energy from solar, atmospheric, and subsurface sources. The relationship between temperature and the distribution and migration of marine and anadromous fishes has long interested researchers. Along the west coast of the United States and Canada during years of unusually warm surface water, pelagic species common to the lower latitudes in the northeast Pacific have been recorded far north of their normal range, and, in some cases, changes in coastal migratory patterns have been recorded (Hubbs and Schultz 1929; Walford 1931; Radovich 1961; Royal and Tully 1961). Since a relationship exists between anomalous temperature and the occurrence of pelagic species, temperature may provide a means of predicting, within seasonal and statistical limits, the occurrence or distribution of coastal marine and anadromous species. The objective of this study was to define the relationships between catch (as a measure of apparent abundance), and temperature, for selected species in different geographical and environmental areas.

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Part I of this paper uses data from monthly airborne infrared temperature surveys off central and southern California conducted during the 5-yr period 1963-68, and catch data from sportfishing boats as collected by the California Department of Fish and Game (CF & G), to determine the temperature at which several important species were caught by the recreational fishery fleet.

Part II describes the results of a more detailed airborne temperature study which took place at an important recreational fishing area off San Diego from April through October in 1972-74. This second series of airborne surveys used increased survey intensity (weekly vs. monthly) over a high catch rate area for the sportfishing fleet, in order to determine the correlation of catch-per-unit-effort (CPUE) to temperature and the statistical significance of differences in temperature-dependent catch rates. The statistical analysis of the data collected off San Diego is presented in the analysis and conclusions section of Part II. Data presented in Part II apply to the general temperature-catch relationships in Part I.

PART I—CATCH AND TEMPERATURE OBSERVED FOR SEVERAL RECREATIONAL AND COMMERCIAL SPECIES OFF CENTRAL AND SOUTHERN CALIFORNIA

In August 1963, the National Marine Fisheries Service (then the U.S. Fish and Wildlife Service, Tiburon Marine Laboratory, Tiburon, Calif.) initiated a program in cooperation with the U.S. Coast Guard to conduct monthly airborne temperature surveys using infrared techniques to measure temperature over three important coastal fishing areas off the west coast. These airborne temperature surveys were continued by the U.S. Coast Guard into 1979. Results of the first 5 yr of surveys (1963-68), in the form of individual survey and monthly average temperature charts for the three areas, were published by Squire (1971). Although those airborne infrared temperature surveys are useful to many fields of environmental research, they were primarily intended to develop temperature data which could be analyzed with catch data to provide insight into catch temperature relationships for some of the more important coastal species.

The central survey area off the California coast from Point Arena to Point Sur and offshore about 50 nmi (Fig. 1a), and the survey area off southern California (Fig. 1b), supplied the temperature data for this paper. The southern area extended to about 110 nmi offshore at its widest point, and from off the coast of Point Arguello, Calif., to Point Salsipuedes, Baja California, Mexico. Data from the northern survey area, which covered the coastal waters from Cape Flattery, Wash., to Cape Lookout, Oreg., for about 50 nmi offshore, were not included. From the published monthly survey data, the temperature was obtained for each CF & G block area (10′ longitude × 10′ latitude geographical area) by month, and these data were used in the calculations for Part I.

Monthly catch data recorded by the commercial sportfishing fleet for the period August 1963 through July 1968 were obtained through the cooperation of the CF & G, Marine Resources Laboratory, Long Beach, Calif. Fishes selected for study included two species of salmon (chinook, *Oncorhynchus tshawytscha*, and silver salmon, *Oncorhynchus kisutch*), which enter the catch off the San Francisco, Bodega Bay, and Monterey Bay area. Data on these species were combined in the CF & G sportfishing boat catch records. Off southern California and northwestern Mexico, catch data were obtained for yellowtail, *Seriola dorsalis*; Pacific bonito, *Sarda chiliensis*; Pacific barracuda, *Sphyraena argentea*; albacore, *Thunnus alalunga*; and white seabass, *Atractoscion nobilis*. All of the latter group are important to the marine sport and/or commercial fishing industry of the United States, and some are important to Mexico. Albacore is taken in substantial quantities by the southern California sportfishing fleet, but most of the catch is taken outside the boundaries of the area

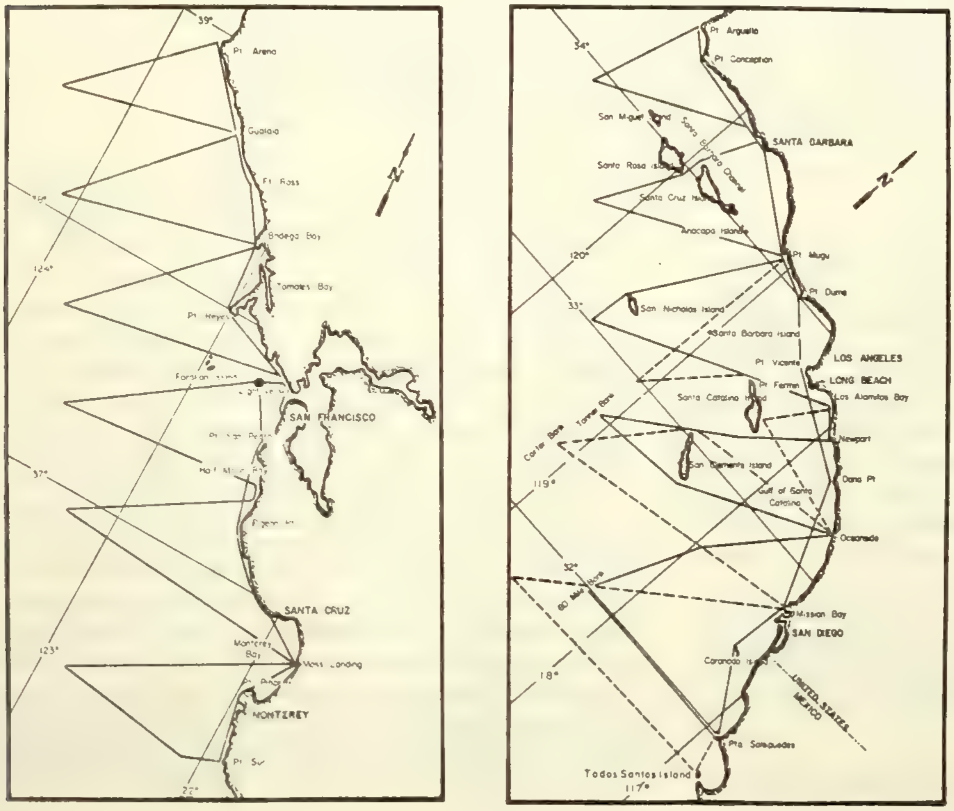


Figure 1.—Airborne infrared sea surface temperature survey tracks: left, central survey area; right, southern survey area.

surveyed. Only catch temperature data for albacore catches within the survey area are given.

Each sportfishing boat operating for hire from California is required by CF & G to maintain a daily fishing log of the catch by species, location of catch (block area number), and number of fishermen on board. Catch records do not indicate species targeted by anglers, or the fishing technique used. A species-preference order is known to exist with the coastal recreational fishermen; in the north, salmon is a highly desirable species, and off southern California, albacore, yellowtail, Pacific barracuda, and white seabass are high on the preference list. In addition, species-specific lures and/or live bait are fished near the surface, in midwater, or close to the bottom. The lack of detailed catch data prevents the allotment of "effort" to the catch of any one species. However, the catch and numbers of anglers participating may be related, particularly for those species that are of high priority to the marine angler. Reports of better-than-average fishing, whether true or not, usually result in increased fishing effort; therefore the catch may or may not be a reflection of increased availability in localized fishing areas. The relationship of catch to number of anglers for data collected in 1972 through 1974 is discussed in Part II.

Basic environmental data for the analysis involved monthly temperature measurements derived from isotherm charts drawn from airborne infrared temperature data for the period August 1963 through July 1968. The surveyed region included 40 block areas off central California having a reported catch of salmon (2,460 temperature observations), and 130 block areas off southern California in which catches of either yellowtail, Pacific bonito, Pacific barracuda, albacore, or white seabass were reported (7,800 temperature observations). Temperature data developed from continuous analog measurements in degrees Fahrenheit are given as Celsius and Fahrenheit.

Monthly catch locations for the 5-yr period were obtained from the CF&G sportfishing boat log records for catches of 347,867 salmon, 161,375 yellowtail, 4,047,292 Pacific bonito, 2,439,512 Pacific barracuda, 129,535 albacore, and 42,328 white seabass.

Results

Data on catch by species for each month from August 1963 through July 1968, and monthly temperature data for the 5-yr survey period, were processed by the Northwest Fisheries Center, Seattle, Wash. A computerized data analysis determined the following: the mean catch temperature, $\bar{X}=\frac{\Sigma(f1\times 1+f2\times 2+\ldots)}{\Sigma(f1+f2+\ldots)}$; the standard deviation about the catch temperature mean (α); and the array of catch by temperature as well as the number of fish in each sample for each species by total area, and by individual block area, month, and year. Temperature ranges, means, and standard deviations were calculated for the same geographical areas and time groups as the species data.

Data are presented for salmon off central California, and for yellowtail, Pacific bonito, Pacific barracuda, white seabass, and albacore off southern California (Fig. 2-19c). These illustrate catch, catch temperature, and temperature range on a regional geographical basis (central California and southern California).

Central California (Monterey Bay, San Francisco, and Bodega Bay)

The ocean temperature of the major fishing area for salmon (from Monterey Bay to off Bodega Bay) ranged from 9.4° to 16.7°C (49.0° to 62.0°F). Waters in this area are coolest during January through May or June, with the lowest temperature recorded in April. Temperatures increase slightly from June through September when the peak average temperature occurs, then drop again after September.

Major peaks in the salmon catch for the fishing area off San Francisco occur in March and July (Fig. 2). To the north of Bodega Bay, the peak catch is in July, and south of Monterey two catch peaks occur, one in May and one in July. Chinook are the salmon most often caught, because as the Sacramento River system holds spawning chinook salmon during most of the year and these pass through the major ocean fishing areas off central California. However, the fall run of chinook salmon is the largest, and fish congregate off the San Francisco Bay area for the spawning migration.

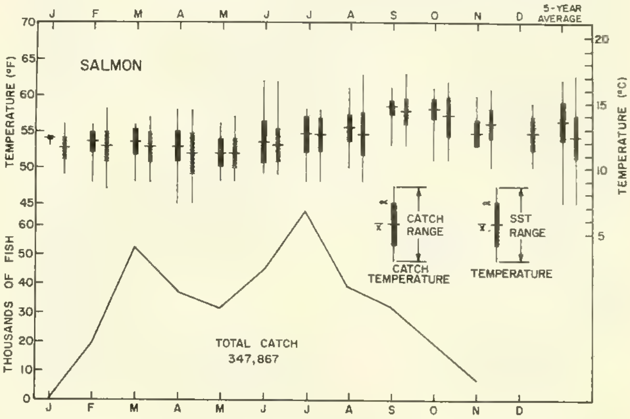


Figure 2.—Distribution of salmon catch off northern California (Monterey Bay to Bodega Bay) by month, August 1963–July 1968, for total catch, catch temperature, and sea surface temperature range and means, and the standard deviation about the means.

The catch temperature mean for all salmon catches off San Francisco for the 5-yr period is greater than the sea surface temperature mean, except for November (Fig. 2). The monthly catch temperature mean is equal to or greater than the temperature mean from January through October, which indicates that more salmon were caught when the temperature was greater than its monthly mean. The catch temperature mean was below the temperature mean during November; however, this was a period of near zero salmon catch. Figure 3 indicates those blocks having a recorded catch of 1,000 salmon or more during the survey period, the month having the greatest catch, the temperature at which most salmon were caught, the mean catch temperature, and the number of salmon in the sample.

The major fishing area off San Francisco early in the year is in the vicinity of Point Reyes, south of Drakes Bay and Duxbury Reef (March/blocks 447, 448, and 449). The major fishing area moves to near the Farallone Islands and the San Francisco Light Buoy during the summer (June-July/blocks 456, 457, 458). In late summer the fishing area moves closer to the Golden Gate (August-September/blocks 446, 455). Mean catch temperature ranged from 11.2° to 13.6°C (52.2°-56.5°F).

The review of the three leading block areas (448, 446, 457) in catch is given in Figure 4a, b, c, showing for each block area the distribution of catch by temperature and by month for catch, temperature at which most salmon were taken, the monthly mean catch temperature, and standard deviation of the mean catch temperature.

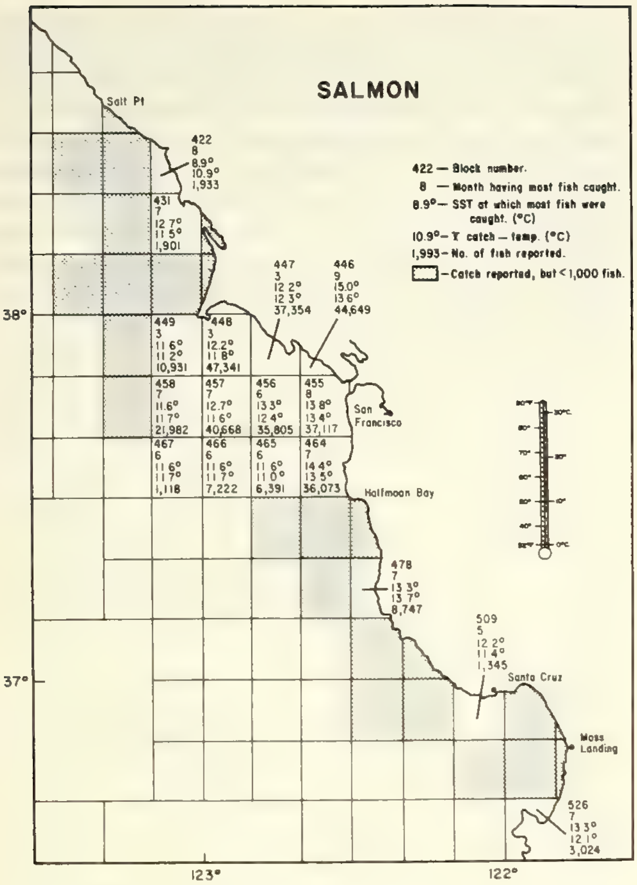
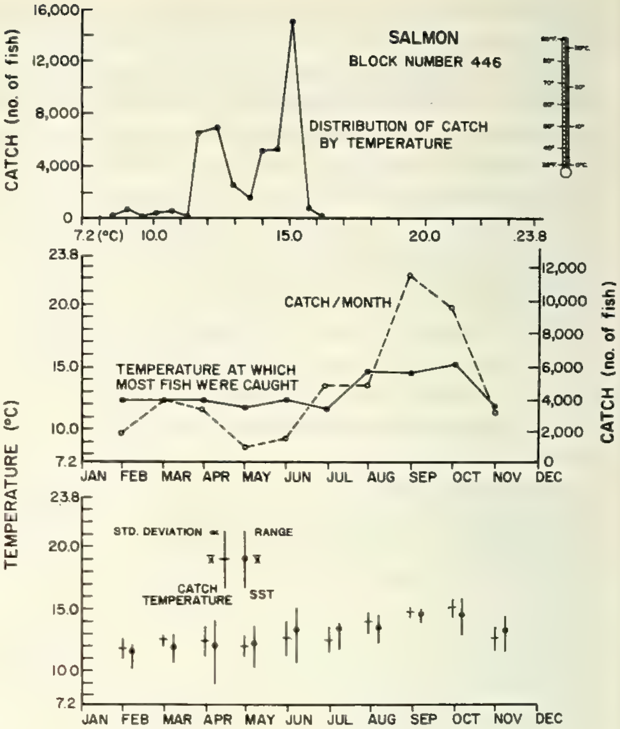
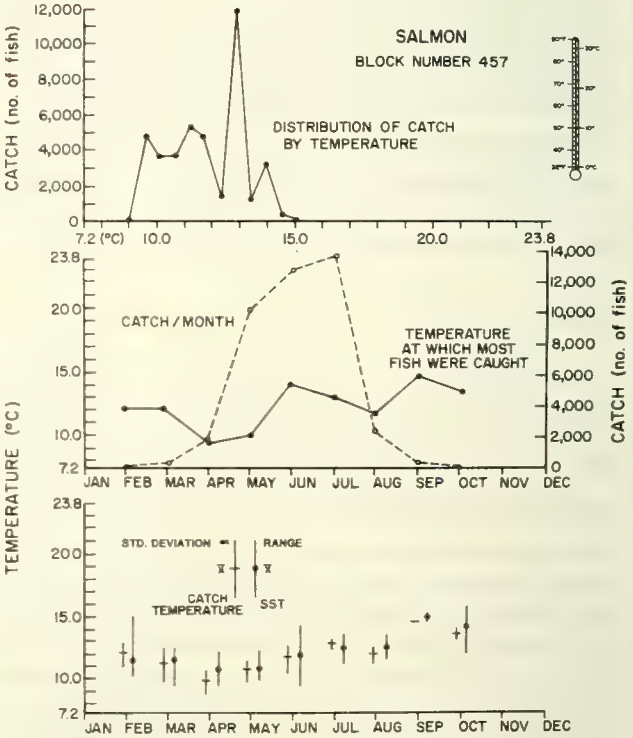


Figure 3.—Catch and temperature data by block area for salmon caught off northern California.





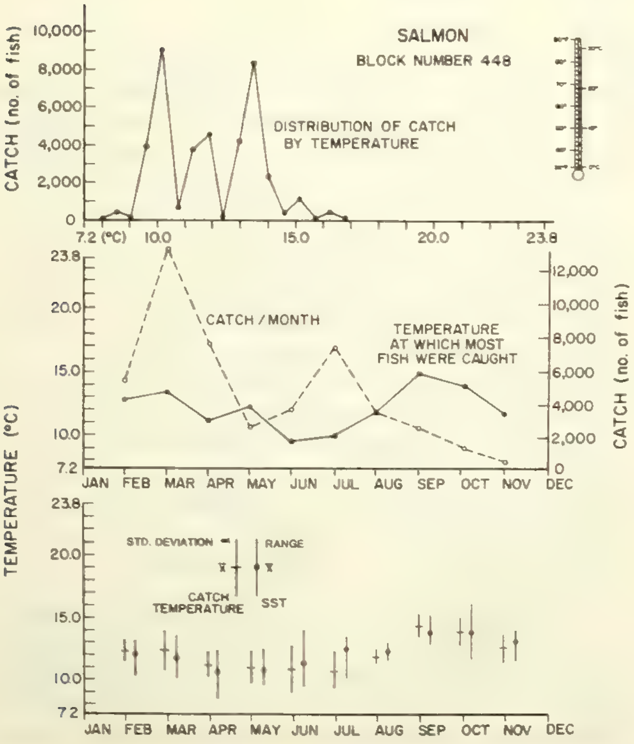


Figure 4.—Distribution of catch by temperature and by month for catch, temperature at which most salmon were taken, mean catch temperature and its standard deviation, and sea surface temperature range and means for the three major block areas having salmon catches. Left, block 448; top, block 446; bottom, block 457.

Southern California (Point Conception to Coronado Islands, Mexico)

During the surveys, temperatures off southern California ranged from 9.4° to 23.3°C (49.0°–74.0°F). The coldest temperatures were in areas near Point Conception and the Santa Barbara Channel Islands, and the warmest temperatures occurred offshore southwest of Dana Point. Mean temperatures ranged from 12.0°C (55.1°F) off the Point Conception-Santa Barbara Channel Islands area, to 20.8°C (69.5°F) off Dana Point.

Yellowtail.—The yellowtail is a pelagic coastal migratory species and commonly ranges from the southern tip of Baja California, Mexico, to near Point Conception, Calif. It is one of the most important sport fishes in southern California and an important commercial species in Mexico. The major sportfishing areas for yellowtail at the northern portion of their range are the Coronado Islands, Mexico, the kelp beds off Point Loma and La Jolla, Calif., and Catalina Island. These fish are caught off southern California in quantity only during the summer migration north from off the Baja California coast. The distribution of yellowtail catch and temperature off southern California (Fig. 5) shows that the catch temperature mean is higher than the sea surface temperature mean in all months except September, October, and November. These results indicate that greater catches are made in months when temperature is above the mean.

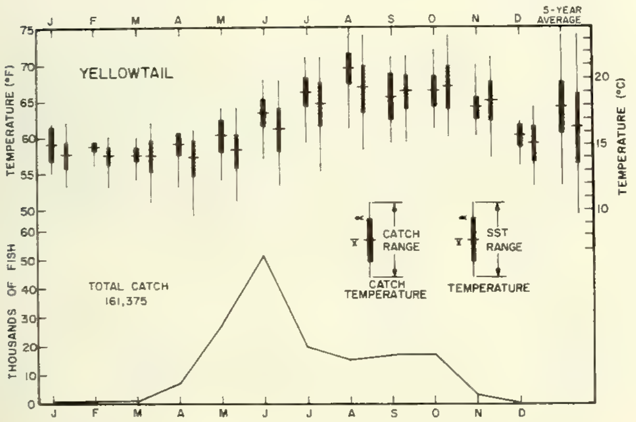


Figure 5.—Distribution of yellowtail catch off southern California and northern Mexico by month, August 1963–July 1968, for total catch, catch temperature, and sea surface temperature range and means, and the standard deviations about the means.

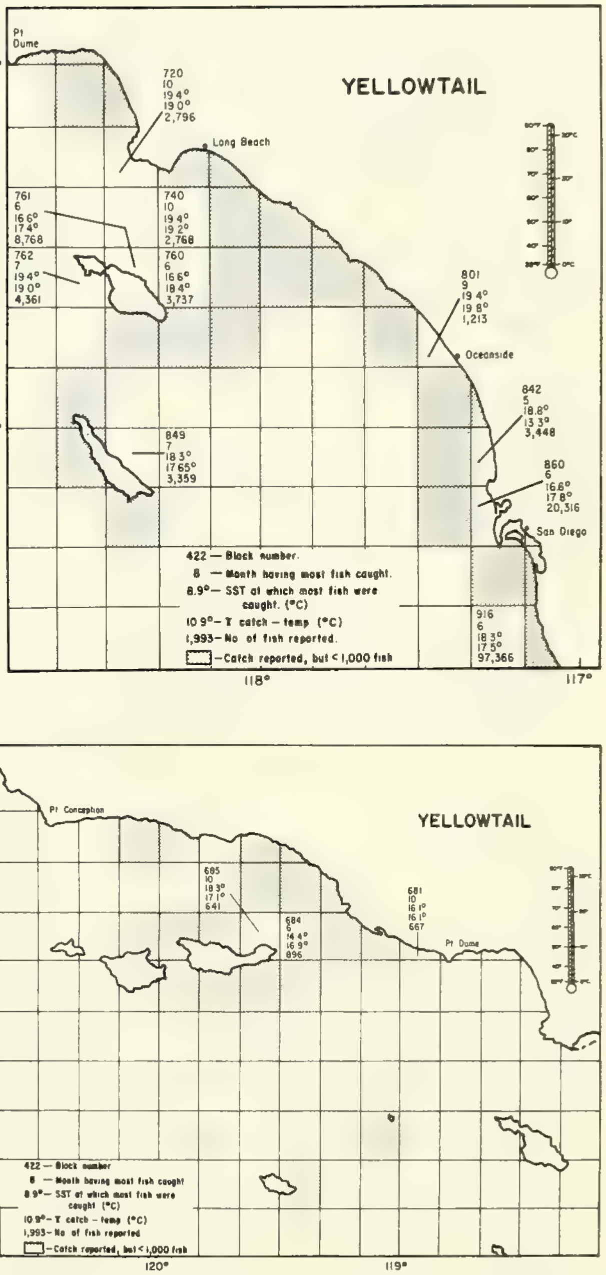
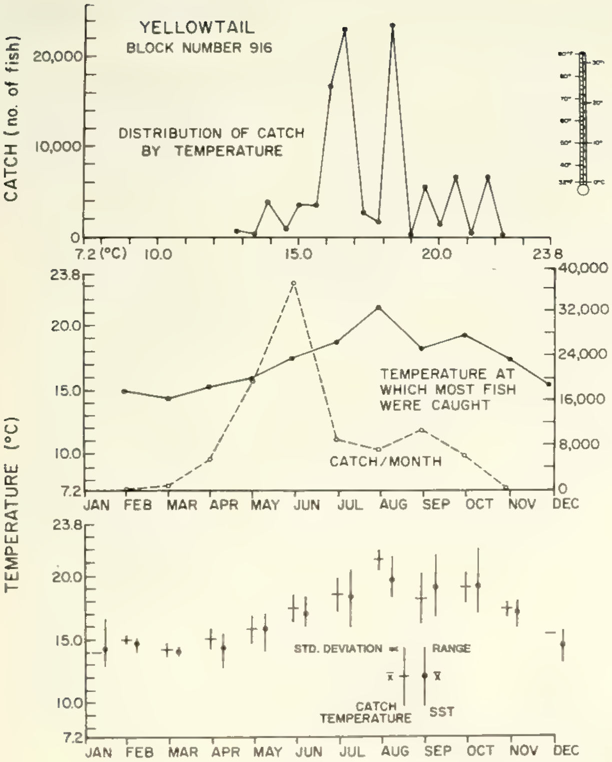


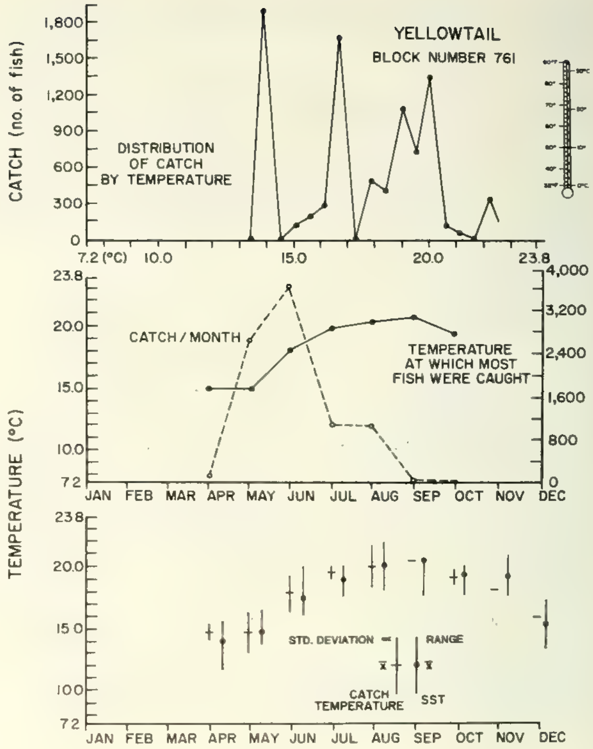
Figure 6.—Catch and temperature data by block area for yellowtail caught off southern California.

Figure 6a and b give the following information by block area for those areas having a catch of 1,000 or more yellowtail during the survey period: the month of the greatest total catch; temperature at which most yellowtail were caught; the mean catch temperature; and the number of yellowtail in the sample. The yellowtail's seasonal migration northward can be detected by examining the dominant catch by block area by month. Near the Coronado Islands (block 916), the first catch peak is recorded in June (block 860). The catch peak is also in June off Point Loma and La Jolla; however, yellowtail is taken for a long period during the summer months in this nearshore area. For block areas 761 and 762 north of Catalina Island, the peak catches are in June and July. Fishing along the coast near the greater Los Angeles area (block 720) peaks in October, as it does along the coast west of Los Angeles and off Santa Barbara. There is evidence of a late summer southward migration, as a second catch peak occurs off the Coronado Islands in September. The shift of the catch temperature mean to less than the sea surface temperature mean indicates greater catches during the late summer months, when temperatures are slightly lower than the mean.

Graphs of the temperatures and catches of yellowtail in the three leading block areas (916, 860, 761) are provided in Figure 7a, b, c. These graphics show the distribution of catch by temperature and by month for catch, temperature at which most yellowtail were taken, monthly mean catch temperature, and standard deviation of the mean catch temperature.

Pacific bonito.—Bonito is a species that is known to migrate considerable distances along the coasts of Baja California, Mexico, and into southern and central California. Like the yellowtail, these fish





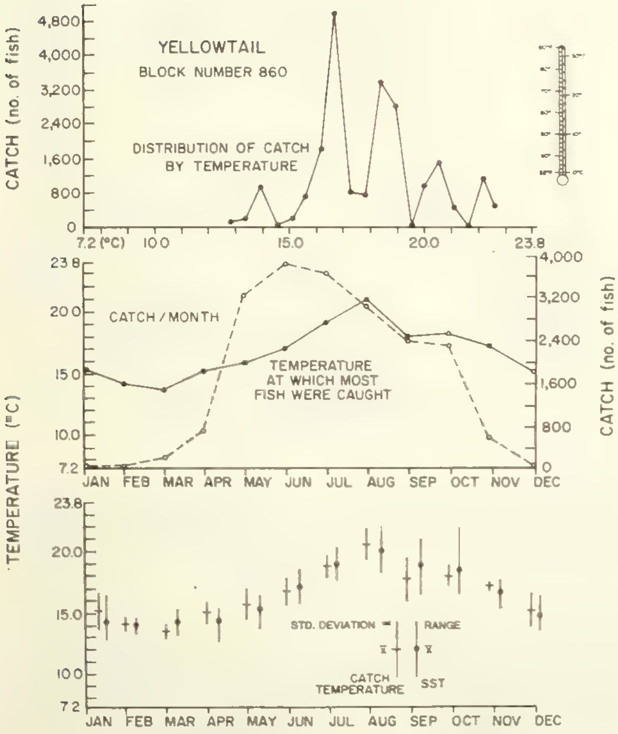


Figure 7.—Distribution of catch by temperature and by month for catch, temperature at which most yellowtail were taken, mean catch temperature and its standard deviation, and sea surface temperature range and means for the three major block areas having yellowtail catches. Top left, block 916; bottom left, block 860; top right, block 761.

show a large increase in their northern latitudinal distribution during seasons when anomalous warm-water conditions exist in the northeast Pacific (Radovich 1961). For all block areas in southern California where bonito are caught, the mean monthly catch temperature is higher than the sea surface temperature mean, except for February, October, and November (Fig. 8). August is the peak catch period, and block 860 located off Point Loma/La Jolla in the San Diego area has the largest recorded annual catch. Figure 9a and b give the following information for block areas having a catch of 20,000 bonito or more during the survey period: the month having the greatest total catch, temperature at which most bonito were caught, the mean catch temperature, and the number of bonito in the sample.

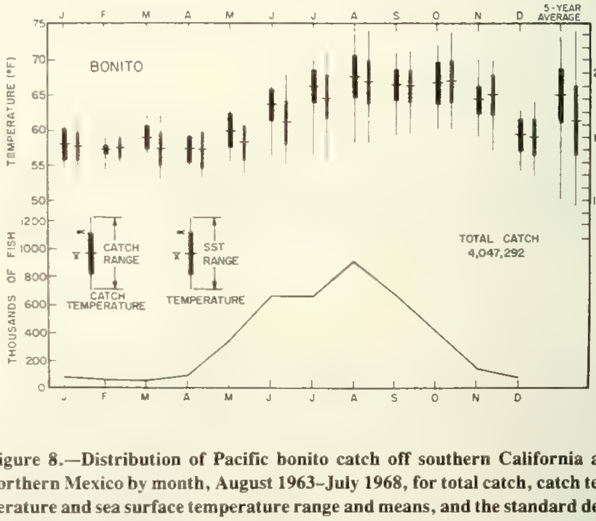


Figure 8.—Distribution of Pacific bonito catch off southern California and northern Mexico by month, August 1963–July 1968, for total catch, catch temperature and sea surface temperature range and means, and the standard deviation about the means.

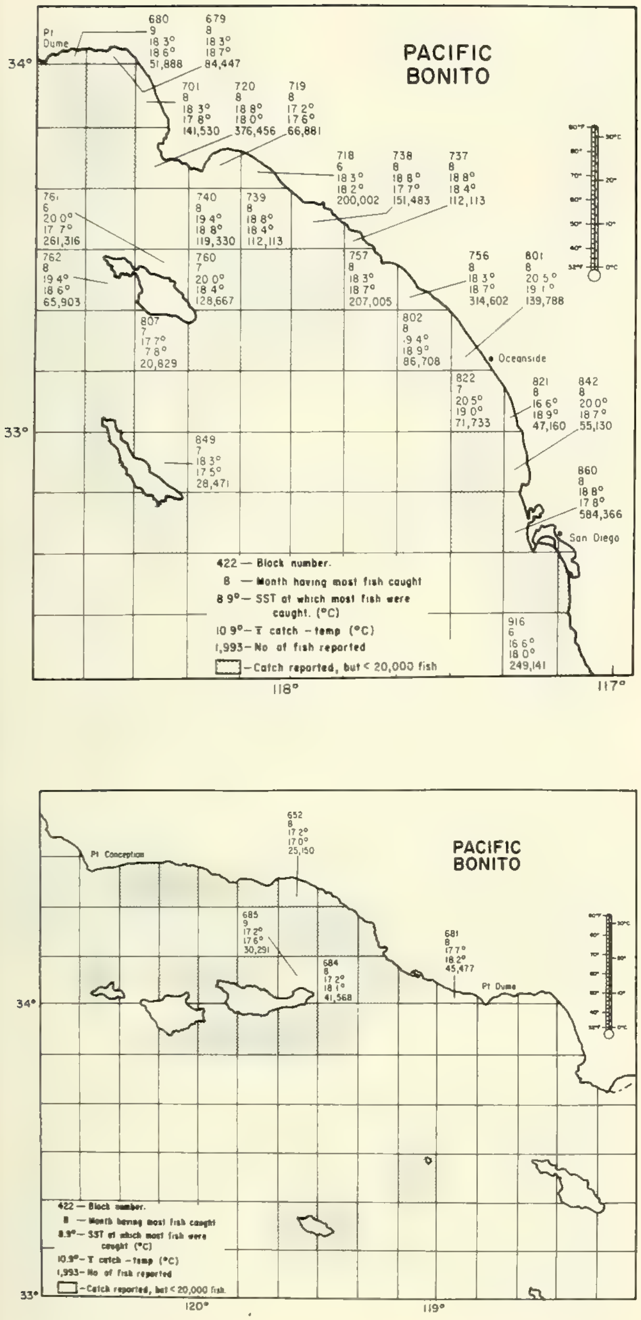


Figure 9.—Catch and temperature data by block area for Pacific bonito caught off southern California.

Graphs of the temperatures and catches of bonito in the three leading block areas (860, 720, 756) appear in Figure 10a, b, c for distribution of catch by temperature and by month for catch, temperature at which most bonito were taken, the monthly mean catch temperature, and standard deviation of the mean catch temperature.

Pacific barracuda.—Barracuda are caught mainly off Point La Jolla (block 860), near the city of San Clemente (block 756), and off Huntington Beach (block 718). Catch peaks occur off La Jolla during August and in Huntington Beach in September, with a few barracuda taken off Santa Barbara and the Channel Islands from August to October. In Figure 11, the catch temperature mean is higher than the sea surface temperature mean in all months except January and February; the means are about equal in those months.

Figure 12a and b show, for block areas having a catch of 5,000 barracuda or more during the survey period: the month having the greatest total catch, temperature at which most barracuda were caught, the mean catch temperature, and the number of barracuda in the sample.

The catch and temperature data for the three leading block areas (860, 756, 718) are given in Figure 13a, b, c for distribution of catch by temperature and by month for catch, temperature at which most barracuda were caught, mean catch temperature, and standard deviation of the mean catch temperature.

White seabass.—All six major block areas for white seabass catches are along the coast from Point Loma to Dana Point, with the greatest numbers of white seabass recorded near Oceanside, Calif. (block 801). August is the peak catch period for the three major block areas, which are located off the coast from near Oceanside to Dana Point. There is still much to learn about the migratory habits of the white seabass, whether inshore, offshore, or alongshore. The catch temperature mean is higher than the sea surface temperature mean (Fig. 14) in all months except March, April, and November.

Figure 15a shows block areas having a catch of 500 or more white seabass during the survey period, and Figure 15b shows block areas with catches greater than 100 fish: both show the month having the greatest total catch, temperature at which most white seabass were caught, mean catch temperature, and the number of white seabass in the sample.

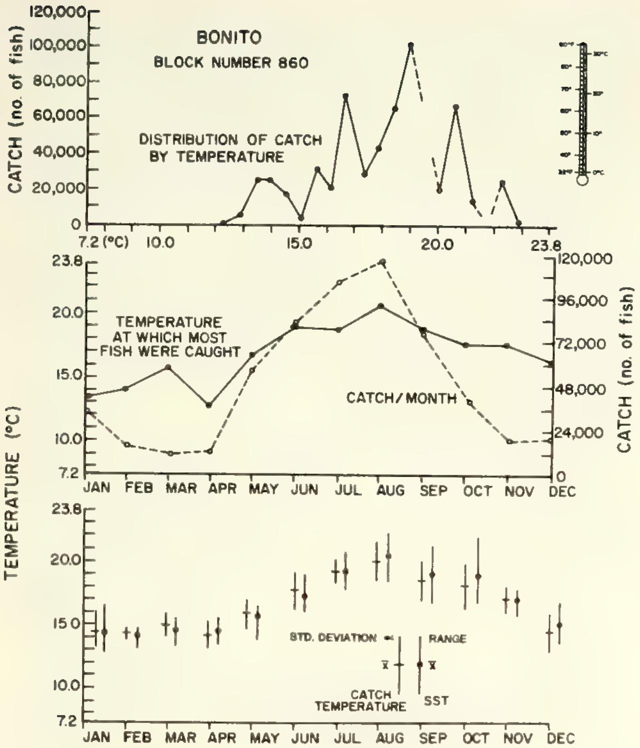
Graphs of temperatures and catches for the three leading block areas (801, 756, 822) are given in Figure 16a, b, c for distribution of catch by temperature and by month for catch, temperature at which most white seabass were caught, mean catch temperature, and standard deviation of the mean catch temperature.

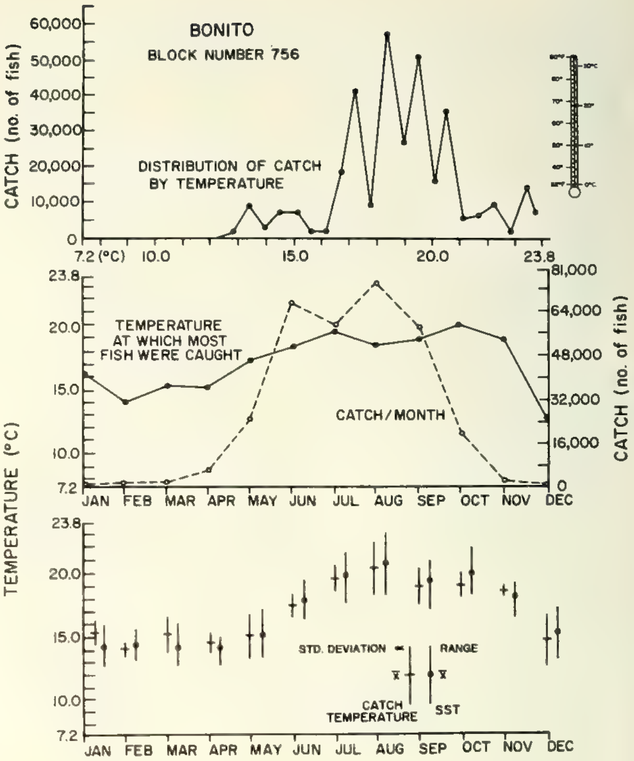
Albacore.—One of the most desirable species caught off southern California is albacore tuna. These fish are commercially important, and support an intensive sportfishery when they appear in fishable concentrations off southern California. The environmental data on which the albacore catch temperatures are based were collected over only the inshore portion of the albacore catch area off southern California and are valid only for the areas covered by the survey and for the sportfishery which provided the catch data.

Figure 17 shows that the peak catch is made during the months of July and August, with minor catches in October and November. A comparison of the catch temperature and temperature means shown in the figure indicates that the catch temperature mean is higher than the sea surface temperature mean in June, but falls below the temperature mean during the peak catch period of August and September. These comparisons indicate that peak catches in the survey area were made in months when temperatures were below the mean.

Block 882 west of San Diego includes the 43 Fathom Bank and is the leading catch area within the area covered by this study. Figure 18a and b give catch and temperature data by block areas having a catch of 1,000 or more albacore: the month having the largest total catch, temperature at which most fish were caught, the mean catch temperature, and the number of albacore in the sample.

Catch and environmental data are given for the three leading block areas (882, 916, 866) in Figure 19a, b, c, for distribution of catch by temperature and by month for catch, temperature at which most albacore were caught, mean catch temperature, and standard deviation of the mean catch temperature.





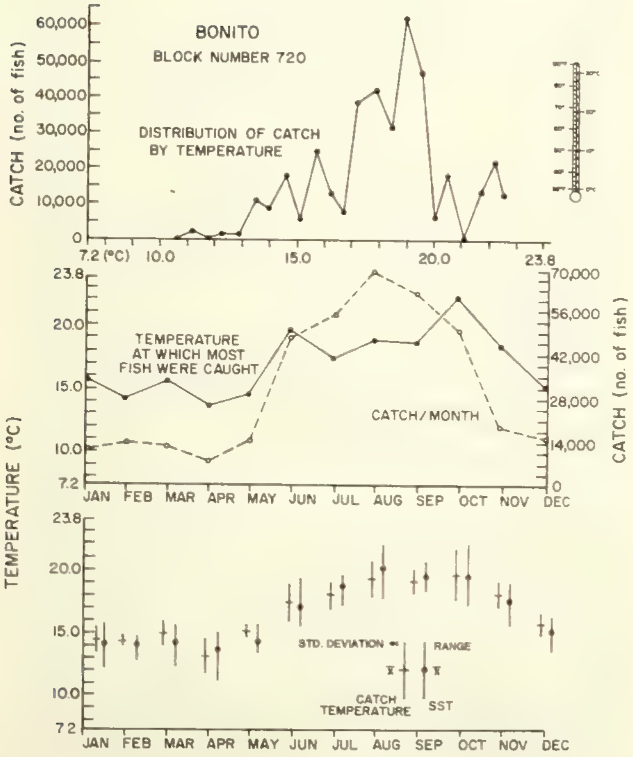


Figure 10.—Distribution of catch by temperature and by month for catch, temperature at which most bonito were taken, mean catch temperature and its standard deviation, and sea surface temperature range and means for the three major block areas having Pacific bonito catches. Top left, block 860; bottom left, block 720; top right, block 756.

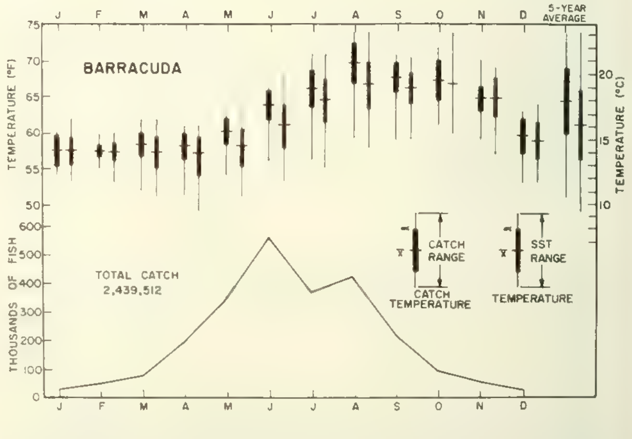


Figure 11.—Distribution of Pacific barracuda catch off southern California and northern Mexico by month, August 1963–July 1968, for total catch, catch temperature and sea surface temperature range and means, and the standard deviation about the means.

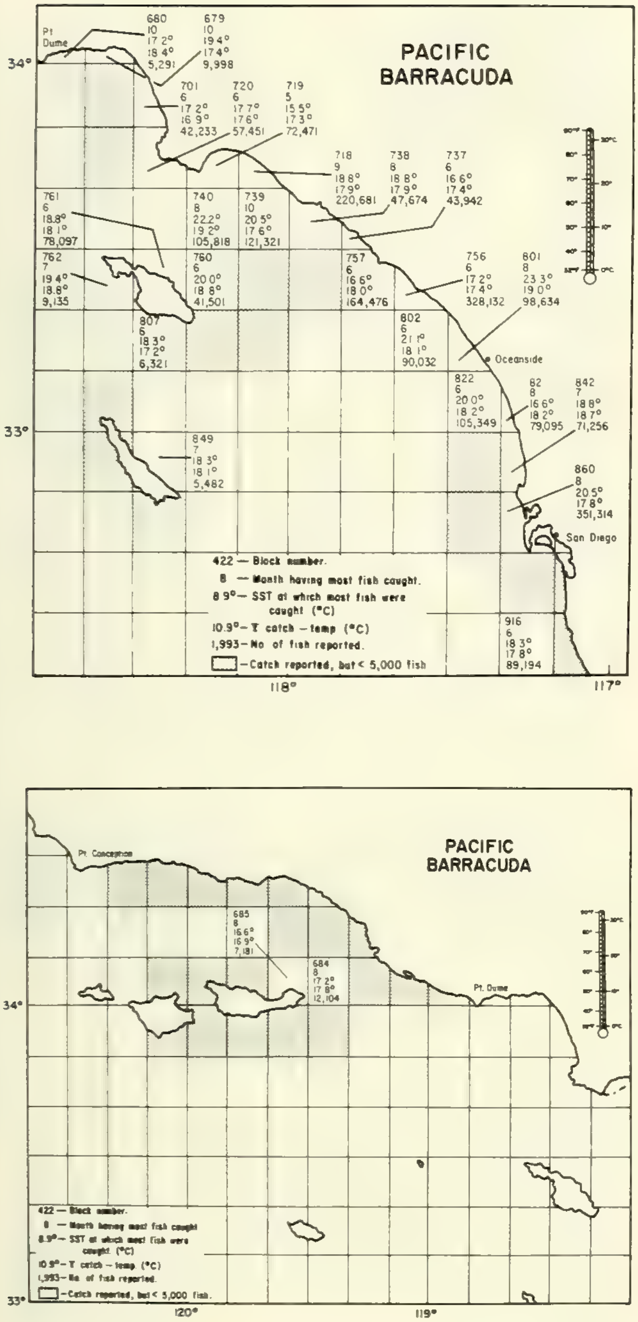


Figure 12.—Catch and temperature data by block area for Pacific barracuda caught off southern California.

PART II—SEA SURFACE TEMPERATURE AND ITS RELATION TO THE CATCH OF THE PELAGIC MIGRATORY SPECIES OF YELLOWTAIL, PACIFIC BONITO, AND PACIFIC BARRACUDA OFF SAN DIEGO

The airborne temperature surveys described in Part I were conducted monthly over a large geographical area. The survey track lines were not specifically designed to cross the geographical centers of sportfishing. Sportfishing effort is concentrated in localized areas along the southern California coast and around the offshore islands (Squire and Smith 1977). Two of the important marine sportfishing areas in southern California are located off San Diego. The Coronado Islands, located southwest of San Diego in Mexico, are in block area 916, a high catch area for yellowtail by the sportfishing fleet. The second high catch area for yellowtail is block area 860 off Point La Jolla. Block area 860 is also the leading catch area for the Pacific barracuda and Pacific bonito, while block area 916 is the third-ranking catch area for Pacific bonito.

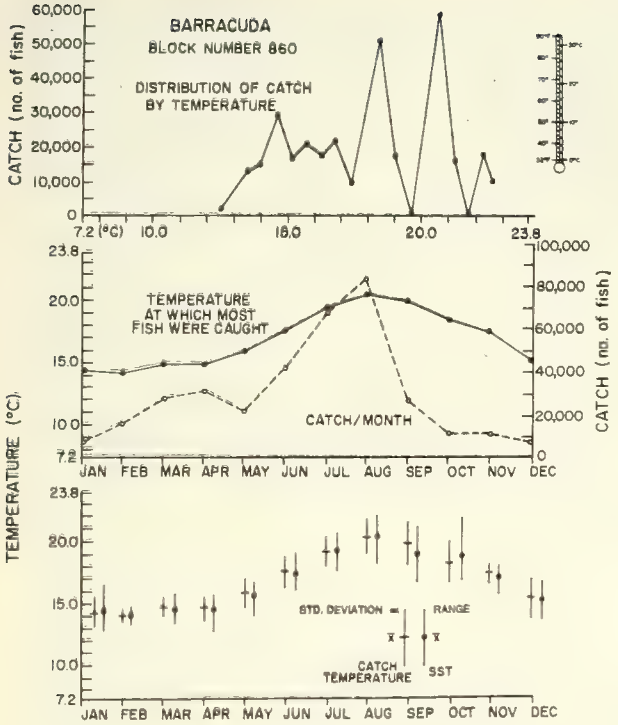
In order to examine the relation of temperature changes to catch, a series of weekly airborne surveys, using an infrared radiometer to measure the surface temperature, were conducted over a 3-yr period, April through October 1972-74. The survey track lines (Fig. 20) were plotted to pass over the sportfishing area directly off Point La Jolla, and the heavily fished kelp bed areas off Pacific Beach and Point Loma. The flight track also passed over the kelp bed located nearshore just south of the United States-Mexico border. These coastal kelp beds are important fishing areas for sportfishing. The survey track also passed near the north end of the North Coronado Islands, an intensively fished area, and over the kelp bed area south of the south Coronado Island (South Kelp). Track lines were flown out to 15 nmi offshore to obtain sufficient data to allow the drawing of isotherm charts. The charts depicted the temperature patterns observed within the coastal area off Torrey Pines State Beach Park, to about 8 nmi below the United States-Mexico border, and to about 15 nmi offshore. Temperatures were calibrated to a "ground truth" measurement, obtained by a simultaneous sea surface temperature measurement made while passing directly over the U.S. Navy Undersea Center (NUC) Oceanographic Tower located about 1.5 nmi offshore from Mission Beach. The results of temperature observations made during the 90 surveys over the 320 nmi survey track conducted during the 3-yr period, and a review of isotherm patterns observed, were published by Squire (1978).

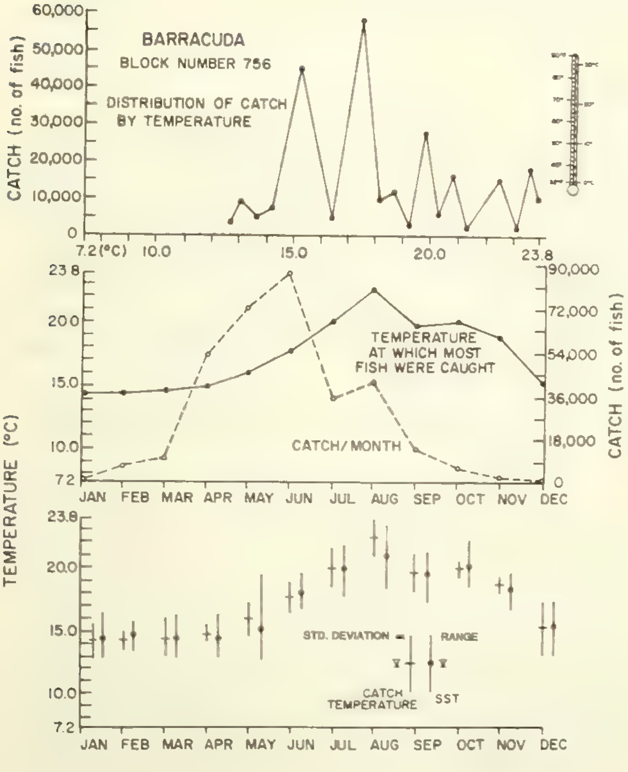
Results

The average temperatures by month obtained over the Naval Oceanographic Tower (NUC) during the 1972-74 series of surveys were similar to those observed in the same monthly time period during the U.S. Coast Guard surveys in 1963-68 (Part I). The NUC tower was used as a "ground truth" calibration point during both surveys. Data pertaining to catch in numbers of fish, in numbers of fish per day, and effort in numbers of anglers per day, were obtained through the cooperation of the CF&G for the 31 wk from April through October 1972-74.

The following is a general description of the temperature patterns from the areas where the fish catch and angler effort data for this study were taken.

The area to the north and northwest of Point La Jolla (blocks 842, 843) usually has temperatures that are greater than those found in other locations in the survey area. An area of upwelling with generally lower temperatures than those observed to the northwest occurs from off Point La Jolla to Pacific Beach, continuing offshore to the southwest (blocks 860, 861). This coastal upwelling area is also indicated by a temperature decline west of the NUC tower (block 860). The kelp bed area west of Point Loma (block 860) appears to be slightly warmer than the area to the north off Pacific Beach. South of Point Loma and about the San Diego harbor entrance channel (block 878), a significant drop in temperature is usually observed. Temperatures south of Point Loma peninsula tend to remain lower than those found to the west, and remain low to the southeast of Point Loma and off the Coronado Strand, increasing slightly inshore off Imperial Beach.





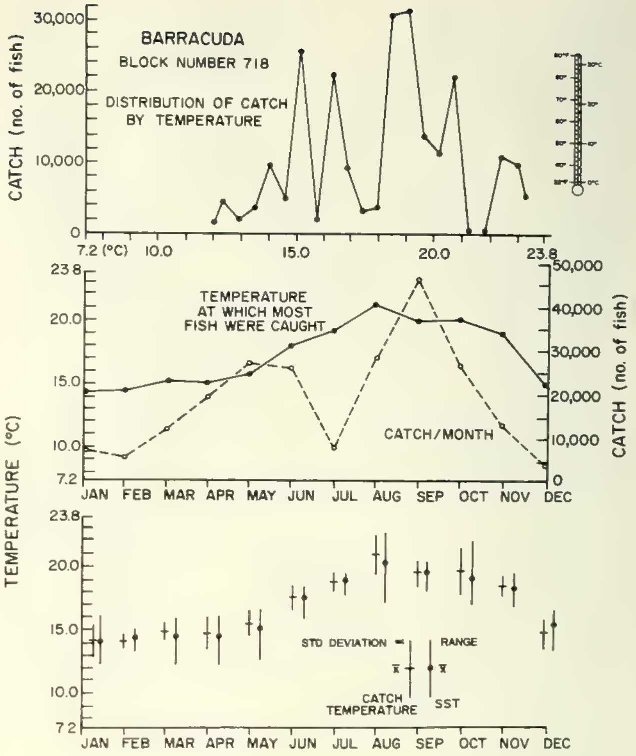


Figure 13.—Distribution of catch by temperature and by month for catch, temperature at which most barracuda were taken, mean catch temperature and its standard deviation, and sea surface temperature range and means for the three major block areas having Pacific barracuda catches. Top left, block 860; bottom left, block 756; top right, block 718.

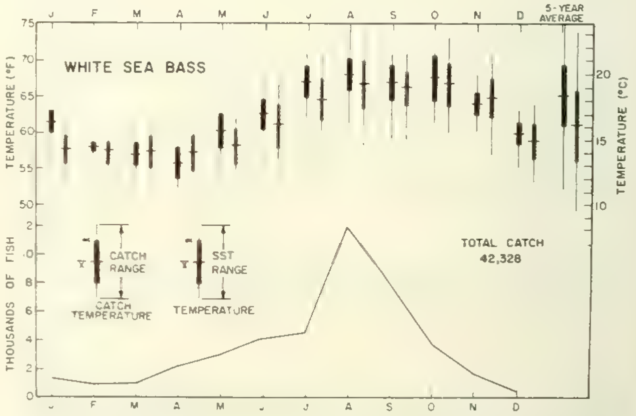


Figure 14.—Distribution of white seabass catch off southern California and northern Mexico by month, August 1963–July1968, for total catch, catch temperature and sea surface temperature range and means, and the standard deviation about the means.

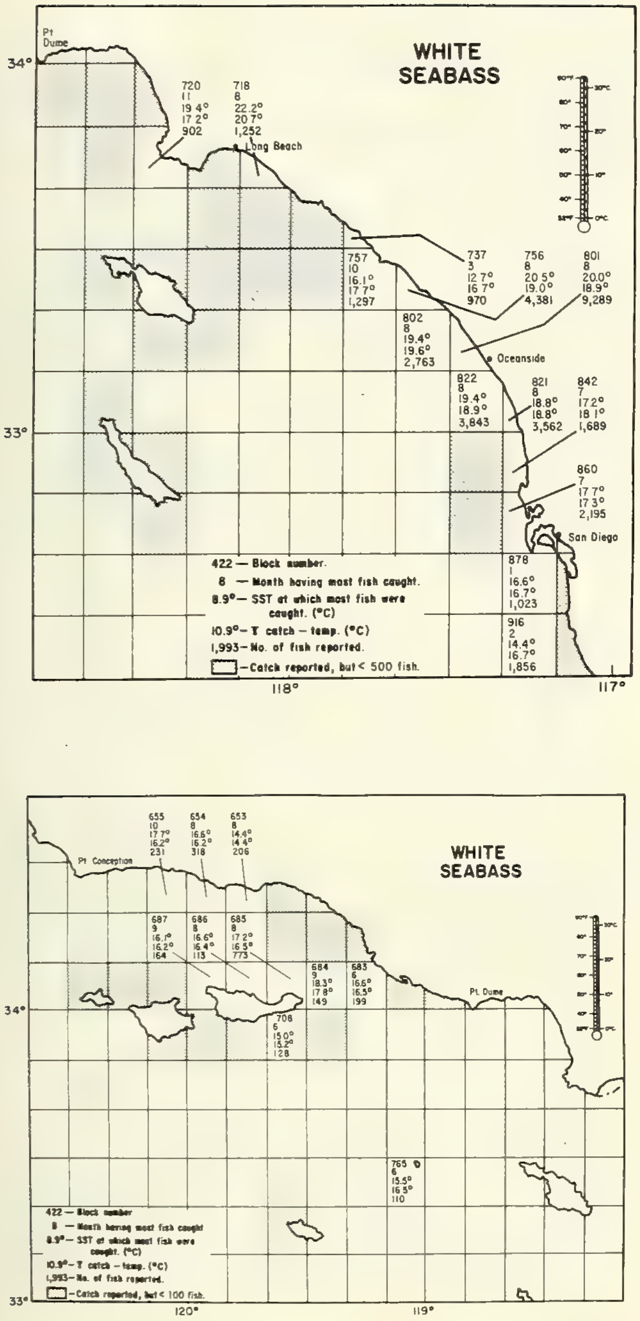


Figure 15.—Catch and temperature data by block area for white seabass caught off southern California.

Along the coast south of the United States-Mexico border, the northern boundary of an extensive coastal upwelling zone is frequently observed. The upwelling increases along the shore to the south and often extends further offshore. Temperatures warmer than those found near the coast of Mexico occur offshore about the Coronado Islands (block 916); these temperatures are more typical of those found nearshore off Point La Jolla in the northern portion of the survey area.

The 3-yr survey period off San Diego showed that 1973 was cooler than 1972, which was a year with above-normal warming along the west coast of North and South America ("El Nino" year). The average temperatures in 1974 were warmer than those in 1973, but not as warm as those in 1972. In 1974, however, an anomalous short-term warming period occurred in early July off southern California, and the highest temperatures for the 3-yr period were recorded at that time.

Species of yellowtail, Pacific barracuda, and Pacific bonito were selected for study, since statewide maximum catches of these three species were recorded in 1963–68 surveys from block areas within the study area. These blocks gave the greatest catch sample, and if a relation between catch and temperature exists it may be evident in the data for these block areas.

The temperatures obtained during the surveys, catch in numbers of fish, and the CPUE are given by weeks in 1972–74 for species of yellowtail (block 916), Pacific bonito (block 860), and Pacific barracuda (block 860) in Figure 21, 22, 23 a, b, c.

Catch Temperature Variation

There is considerable variation in catch temperature relative to the geographical location of the temperature measurements. The 1963–68 observations of yellowtail are one example: in the leading block area near the Coronado Islands (block 916), the mean catch temperature was 17.5°C (63.6°F), while 20 mi away off the Point La Jolla–Pacific Beach area (block 860) it was 17.9°C (64.2°F). Farther north about Catalina Island (block 761), it was 17.4°C (63.4°F), similar to that of the Coronado Islands. However, 30 mi north of Catalina Island along the mainland coast off Point Vincente (block 720), the mean catch temperature rose to 19.0°C (66.2°F).

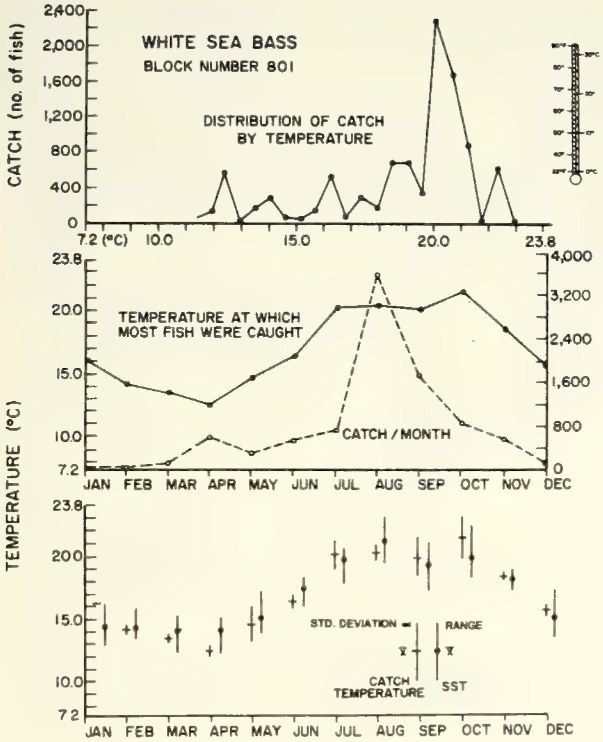
Although catch temperature data are limited for the sport catch of albacore off southern California, catch temperatures west of San Diego averaged 18.3°C (65°F) to 18.9°C (66°F). Airborne temperature surveys off central California observed that commercial albacore fishing operations were in waters of 16.1°C (61.0°F) to 17.2°C (63.0°F) (Squire 1969).

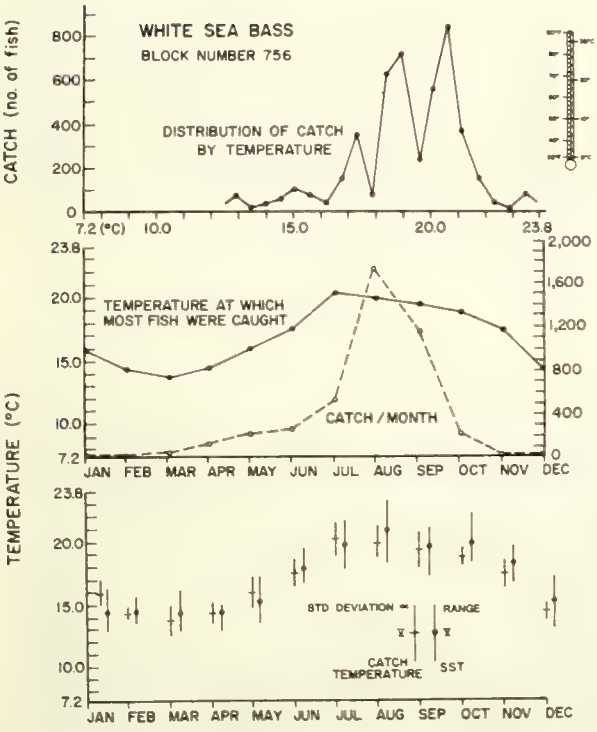
By using the block areas containing major catch as "key areas" for the pelagic species of interest, it is reasonable to assume that temperature and catch data could be used within statistical limits to better define the relation of environment to catch. The 1972–74 surveys were conducted for this purpose and a detailed anaylsis made of the catch, temperature, and effort data.

ANALYSIS AND CONCLUSIONS— PARTS I AND II

In natural populations where sampling is selective rather than random or systematic, it is extremely difficult to separate chance events from fundamental or persistent relationships. This is particularly true of catch-environmental relationships because 1) all organisms seem to aggregate in time and space, 2) the nature of the selectivity (nonrandomness of effort) is itself environmentally related, and 3) spatial-temporal-environmental interactions may completely obscure the main effects.

It is common for fisheries researchers to attempt to establish a relationship between catch and temperature. In a study of this type, the important considerations are that 1) temperature is seasonally cyclical and monotonically increases or decreases within season, and 2) spatial-environmental interactions will alter the probabilites that the population will be within the range of the fishing gear. Thus, in order to establish evidence for temperature preference, one must, at minimum, stratify catch by season and area, and examine the relationship of temperature and catch or CPUE within strata. The limitation of this kind of analysis is that, within strata, the temperature range is





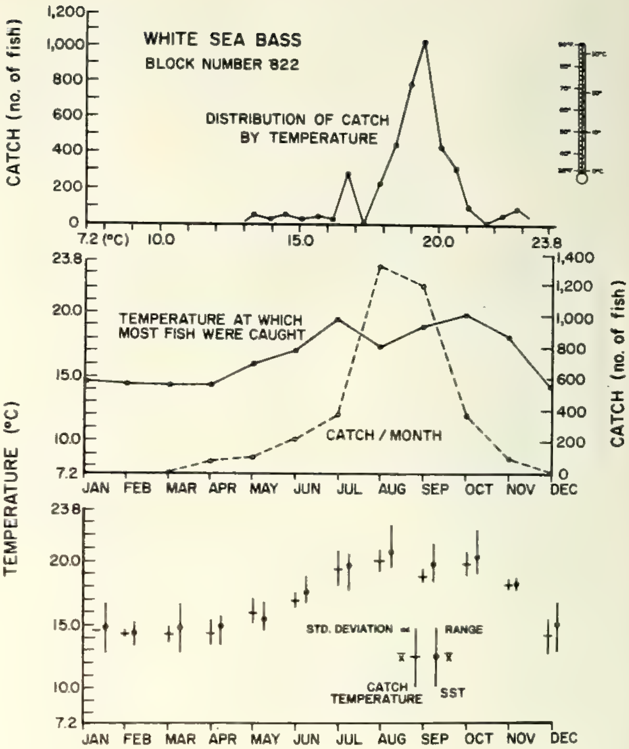


Figure 16.—Distribution of catch by temperature and by month for catch, temperature at which most white seabass were taken, mean catch temperature and its standard deviation, and sea surface temperature range and means for the three major block areas having white seabass catches. Top left, block 801; bottom left, block 756; top right, block 822.

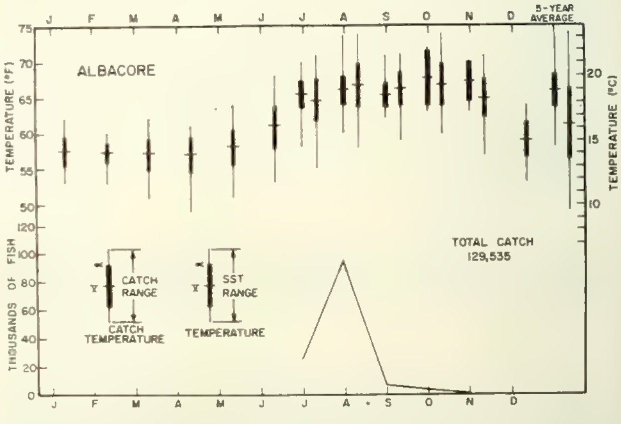


Figure 17.—Distribution of albacore catch off southern California and northern Mexico by month, August 1963–July 1968, for total catch, catch temperature and sea surface temperature range and means, and the standard deviation about the means.

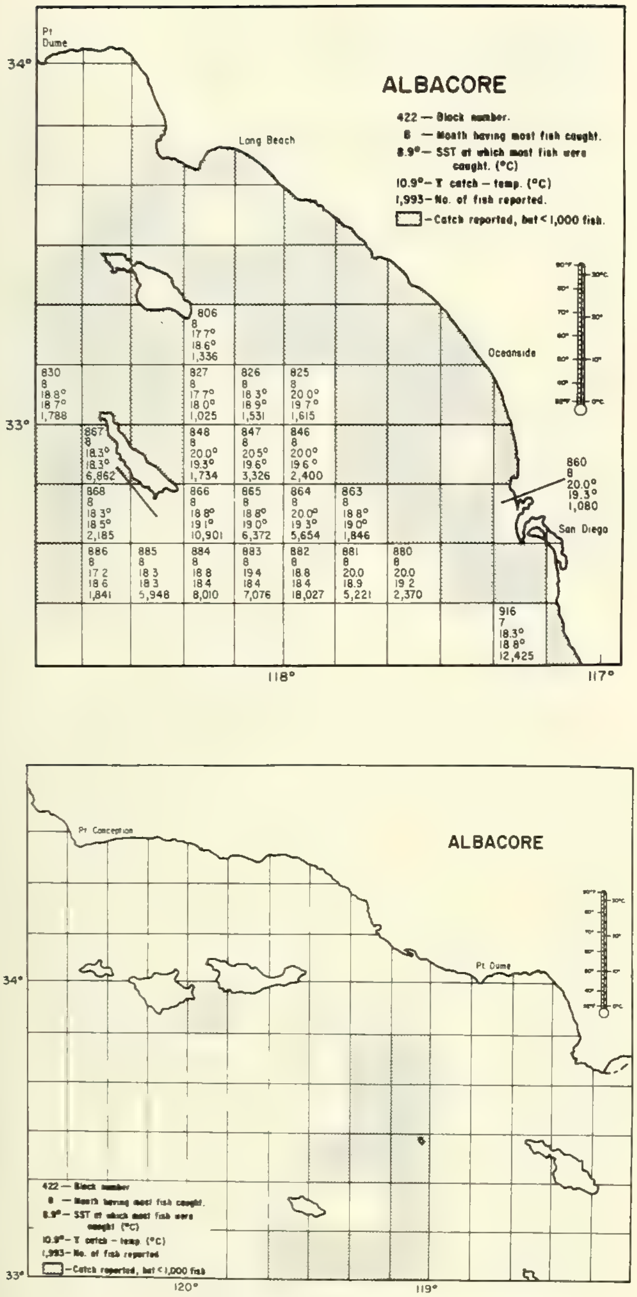


Figure 18.—Catch and temperature data by block area for albacore caught off southern California.

usually small, minimizing the likelihood of significant statistical relationships. It may well be the case that temperature preference can only be established either by 1) the preponderance of evidence in selective sampling investigations, as presented in this report, or 2) intensive investigations within particular temporal-spatial strata.

The catch and temperature data obtained during the 1972–74 surveys were stratified by year and species (Pacific barracuda, yellowtail, and Pacific bonito). For each species, analyses were conducted using the 3 yr of catch in the block area (916 or 860) having the greatest catch for that species. Using data for all 3 yr, cumulative preference curves (Kolmogorov-Smirnov) of catch vs. temperature, and cumulative temperature curves were plotted.

In general, graphs show increased catch rates for all species through the midrange temperatures of 17.8° to 20.0°C (64.0° to 68.0°F), with a reduction in rate above 20.5°C (69.0°F). Table 1 lists the temperature at the 20th, 50th, and 80th percentiles of the catch preference curves for each species. The corresponding percentiles of the temperature curve for the 31-wk period are shown below:

Block	*20%*	*50%*	*80%*
860	16.6°C(62.0°F)	18.6°C(65.5°F)	20.5°C(69.0°F)
916	16.1°C(61.0°F)	18.6°C(65.5°F)	20.2°C(68.5°F)

The average temperature at the 20th catch percentile is slightly above the 20th percentile for temperature, indicating that fewer fish were taken at the very lowest temperatures; beyond that, catch appears representative of the temperature distribution.

Large catches of 30% or more above the means were identified, and the corresponding sea surface temperature for each was recorded. The temperatures for all large catches were averaged by year and are given in Table 2. Overall, large catches ranged in temperature from 16.2°C (61.2°F) to 23.0°C (73.5°F), with a mean value of 19.5°C (67.1°F) for Pacific barracuda, 18.5°C (65.4°F) for yellowtail, and 19.6°C (67.4°F) for Pacific bonito.

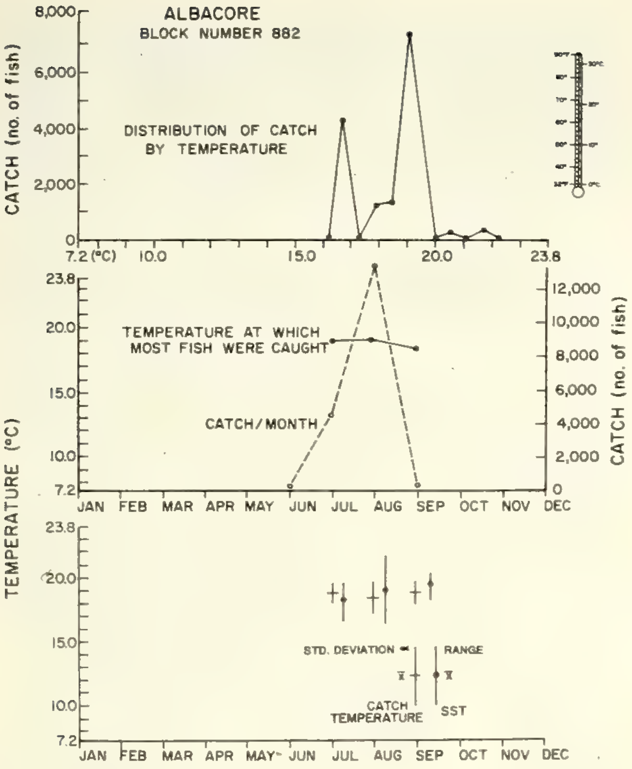
The relationship of catch and temperature may be examined using Spearman and Kendall nonparametric rank correlation tests assuming fishing effort is equally distributed over the temperature range within any time period. The results of these two tests for the relationships of 1) temperature and catch of all species per unit effort, and 2) temperature and catch of all species for the 31 wk, are shown in Table 3. The correlations are consistently higher for catch than for CPUE, indicating an increase in effort with increasing catch. Thus, the temperature and catch relationship will be confounded with changing levels of effort. Therefore, only the relationship of temperature and CPUE was tested in subsequent analyses.

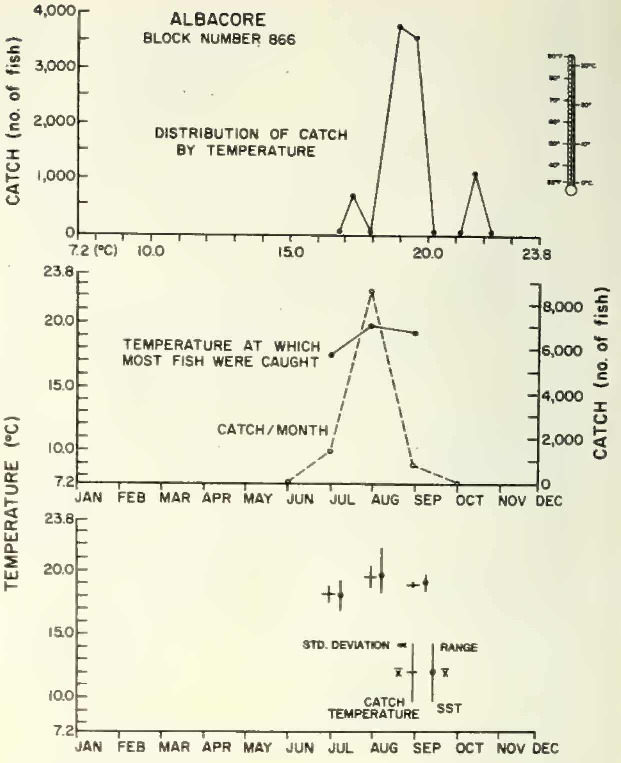
For the 31 wk being analyzed, one of the nine tests was statistically significant at the .05 level using the Kendall test, and two tests were statistically significant using the Spearman test. Since the assumption of equal distribution of effort over the temperature range became less likely as the fishing season progressed, similar tests were carried out for a 17- and a 12-wk period. These results are shown in Table 3. For the 17-wk period, three Kendall and five Spearman tests were statistically significant; for the 12-wk period, two Kendall and six Spearman tests were statistically significant. The Kendall test is more conservative in all cases. On the average, about one-half of the individual tests were statistically significant at the .05 level.

The distribution of catch over the temperature range appeared disproportionate only in the lower temperature range. To examine the possibility of a similar relationship for temperature and CPUE, cumulative CPUE curves were obtained for the three species, and the temperature distribution withing each percentile range (0-20, 20-40, 40-60, 60-80, and 80-100) was recorded. The results for all data combined are shown below. Numbers in parentheses indicate how often catches would be expected in a particular temperature range if temperature had no effect of CPUE.

Cumulative CPUE
(0–observed/E–expected)

	0-20		*20-40*		*40-60*		*60-80*		*80-100*	
	0	*E*	*0*	*E*	*0*	*E*	*0*	*E*	*0*	*E*
12.7°-15.6°C (55°-60°F)	28	(18)	2	(5)	1	(4)	0	(3)	1	(2)
15.6°-18.3°C (60°-65°F)	44	(50)	21	(15)	5	(11)	9	(7)	9	(5)
18.3°-21.1°C (65°-70°F)	69	(73)	19	(23)	25	(16)	11	(10)	6	(8)
21.1°-23.9°C (70°-75°F)	8	(8)	4	(3)	2	(2)	1	(1)	0	(1)





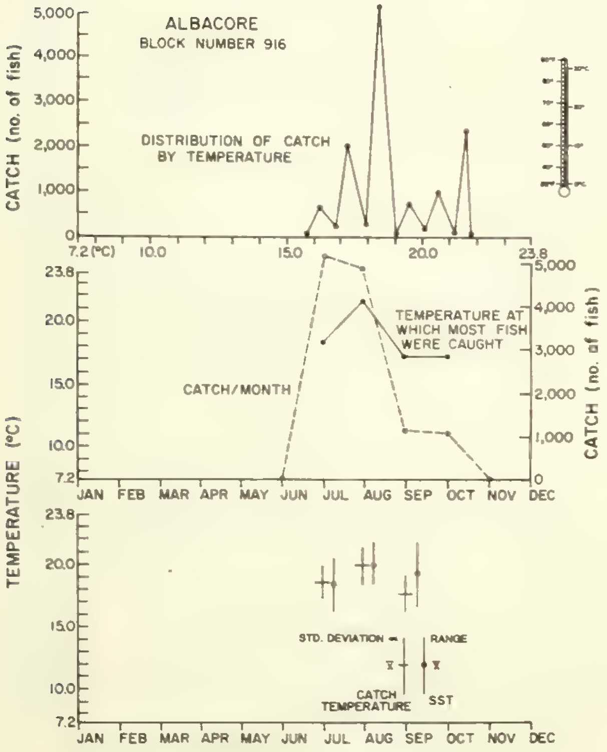


Figure 19.—Distribution of catch by temperature and by month for catch, temperature at which most albacore were taken, mean catch temperature and its standard deviation, and sea surface temperature range and means for the three major block areas having albacore catches. Top left, block 882; bottom left, block 916; top right, block 866.

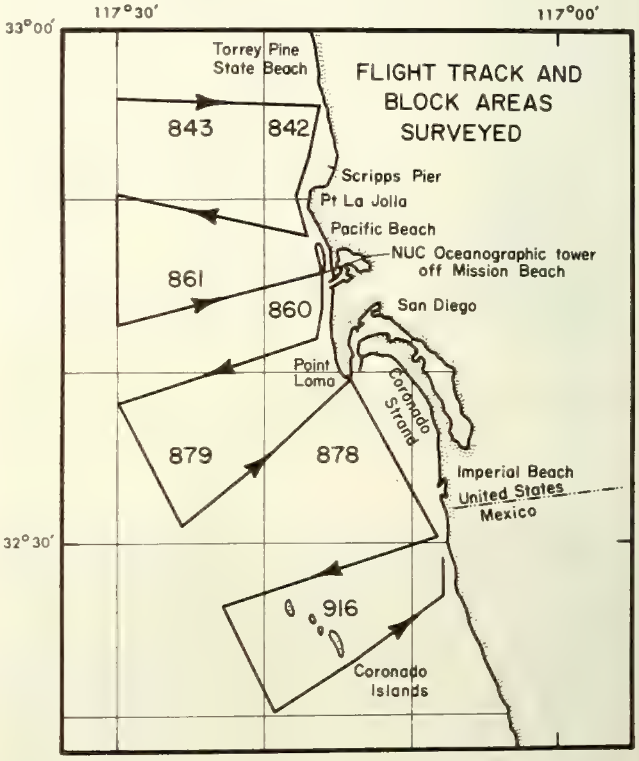


Figure 20.—Survey flight track pattern flown during the 3-yr study of sea surface temperature, April through October, 1974–76.

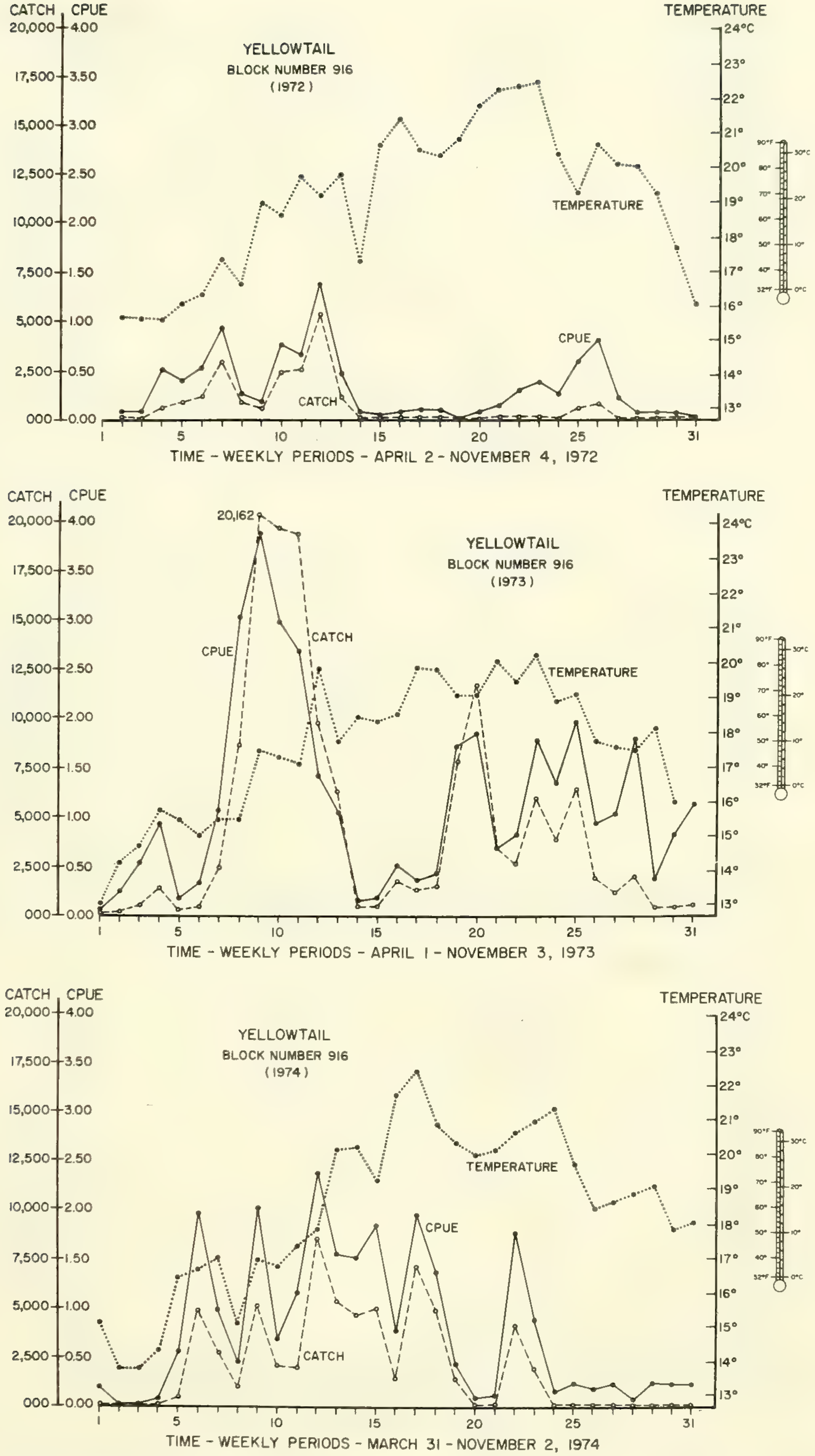


Figure 21.—Plots of CPUE and temperature by weekly periods, April through October 1972 (top), 1973 (middle), 1974 (bottom), for yellowtail catches made in block 916.

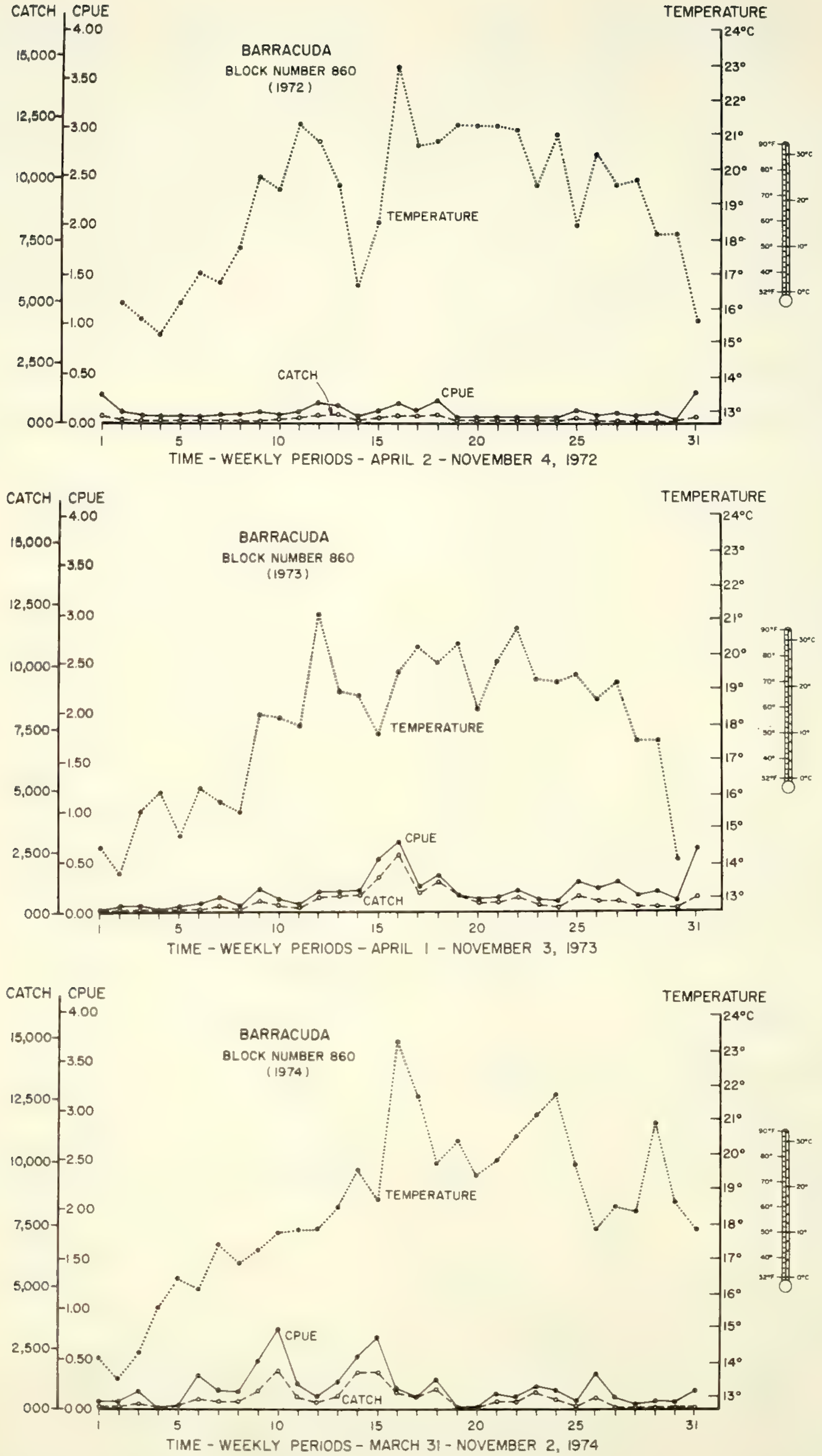


Figure 22.—Plots of CPUE and temperature by weekly periods, April through October 1972 (top), 1973 (middle), 1974 (bottom), for Pacific barracuda catches made in block 860.

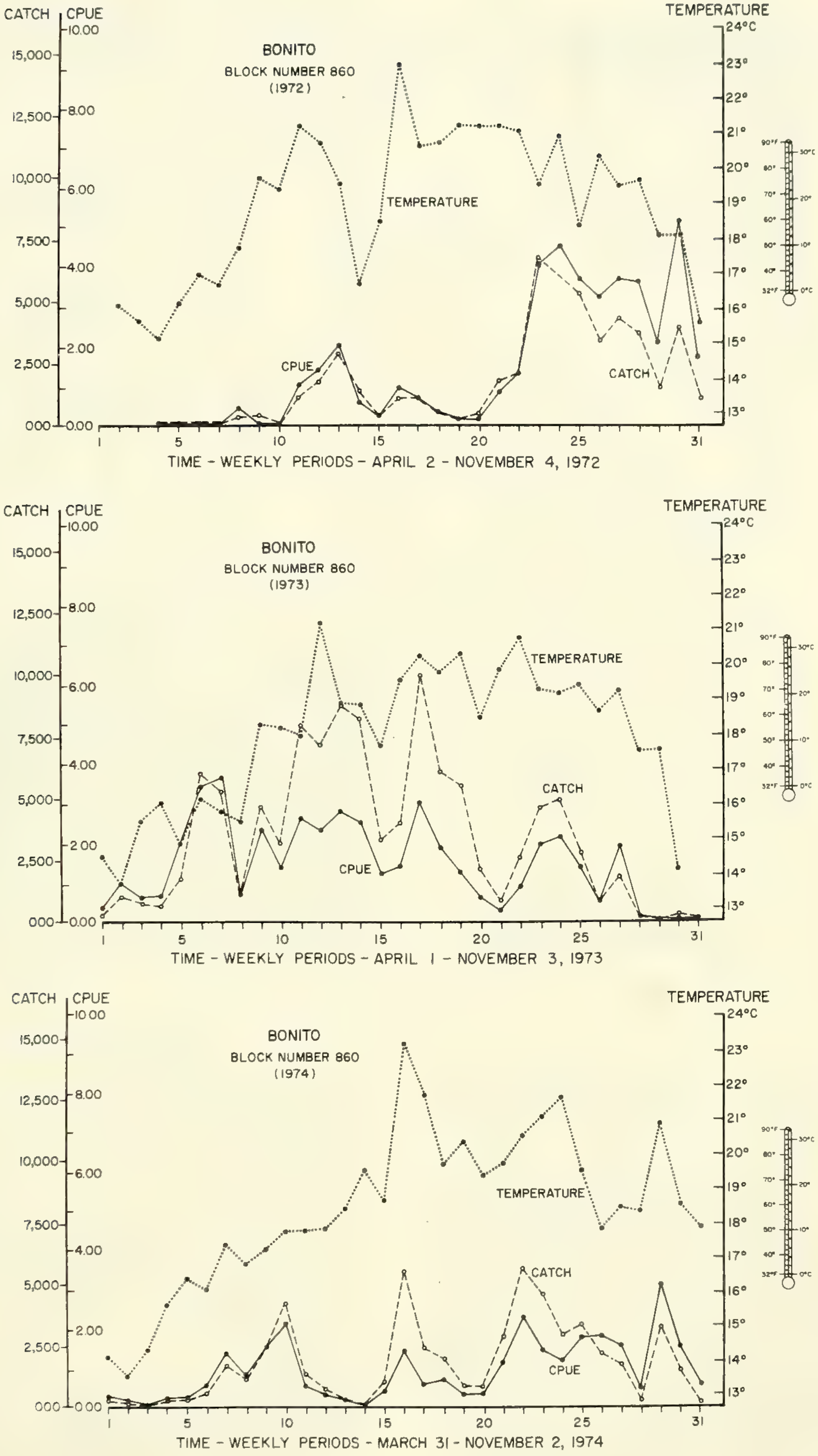


Figure 23.—Plots of CPUE and temperature by weekly periods, April through October 1972 (top), 1973 (middle), 1974 (bottom), for Pacific bonito catches made in block 860.

Table 1.—Breakdown of percent catch to temperatures (° F–° C) observed from Kolmogorov-Smirnov graphs.

	Catch		
Period	20%	50%	80%
17 Weeks			
Barracuda block 860			
1972	64.5° F	67.0° F	69.0° F
1973	63.5	66.0	67.0
1974	63.0	64.5	66.5
$\bar{x}$	63.7 ≥(17.6 ≥)	65.8 ≥(18.8 ≥)	67.5 ≥(19.7 ≥)
Yellowtail block 916			
1972	62.0	65.0	68.0
1973	62.0	62.5	64.5
1974	61.5	63.0	68.0
$\bar{x}$	61.8 ≥(16.5 ≥)	63.5 ≥(17.5 ≥)	66.8 ≥(19.3 ≥)
Bonito block 860			
1972	66.0	67.0	69.0
1973	61.0	65.0	67.0
1974	62.5	63.5	73.0
$\bar{x}$	63.2 ≥(17.3 ≥)	65.2 ≥(18.4 ≥)	69.7 ≥(20.9 ≥)
31 Weeks			
Barracuda block 860			
1972	64.0	67.0	69.0
1973	64.0	66.0	67.5
1974	63.0	64.5	69.0
$\bar{x}$	63.7 ≥(17.6 ≥)	65.8 ≥(18.8 ≥)	68.5 ≥(20.3 ≥)
Yellowtail block 916			
1972	62.0	65.0	68.5
1973	62.0	63.0	66.0
1974	62.5	66.0	69.0
$\bar{x}$	62.2 ≥(16.8 ≥)	64.7 ≥(18.2 ≥)	67.8 ≥(19.9 ≥)
Bonito block 860			
1972	64.5	66.5	69.0
1973	63.5	65.5	67.0
1974	63.5	66.5	70.0
$\bar{x}$	63.8 ≥(17.7 ≥)	66.2 ≥(19.0 ≥)	68.6 ≥(20.4 ≥)

Table 2.—Mean temperatures for large catches.

Species-Period	Catch 1 yr	Mean catch 1 wk	Calculated large catch 1 wk	Mean temperature for large catches 1 yr (° F-° C)	
Barracuda block 860					
1972	3,245	107.7	167.5	67.5° F	67.1° F (19.5° C)
1973	13,303	429.1	686.6	66.1	
1974	13,109	422.9	676.6	67.8	
Yellowtail block 916					
1972	21,441	691.6	1,106.6	65.2	65.3° F (18.5° C)
1973	142,556	4,598.6	7,357.8	64.1	
1974	63,470	2,047.4	3,275.8	66.8	
Bonito block 860					
1972	51,148	1,899.4	3,031.0	66.9	67.4° F (19.6° C)
1973	104,790	3,380.3	5,408.5	66.4	
1974	54,672	1,763.6	2,821.8	68.9	
				$\bar{x}$ 66.6° F (19.2° C)	

Again there is strong evidence that the lowest temperature range, 12.7° to 15.6°C (55° to 60°F), is the only area where catch rates are lower than expected.

While evidence of correlations between angler success and ocean temperature for species of yellowtail and Pacific barracuda have been reported by Radovich (1975), it is difficult to interpret data from investigations where sampling may be selective, especially if the selection is temperature related. The obvious relationship of catch and temperature may simply reflect increased effort, or may be due primarily to sampling above and below the temperature range of the species. The data presented in this report suggest the latter, and there is little evidence to indicate a preferred temperature within the range 15.6° to 21.1°C (60° to 70°F).

Again, it should be stressed that fishery data are not optimum for examining this hypothesis because of the serious confounding of cause and effect. Simultaneous observations of the spatial distribution of the species, environmental measurements over the extent of distribution, and the changes that occur over time, must all be considered before the true relationship of these pelagic species to the environmental factor of sea surface temperature can be established.

ACKNOWLEDGMENTS

I am grateful for the cooperation of the U.S. Coast Guard, Commanding Officer Western Area, and the personnel of the Port Angeles, San Francisco, and San Diego Air Stations who made the first phase of this study possible. I wish to thank Gerry Talbot, Sven Johnson, and other staff members of the Tiburon Marine Laboratory who participated in the U.S.C.G. surveys, and Parke Young of the CF&G. The efforts of staff members of the La Jolla Laboratory who assisted in the San Diego area aerial survey are acknowledged as well as the cooperation of the Statistical Group of the CF&G. Jim Zweifel's invaluable assistance is greatly appreciated in development of the statistical procedures and rationale used in the analysis of Part II, along with Mike Kicpera's efforts in programming, reviewing, and testing the calculations.

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Table 3.—Nonparametric correlation for sea surface temperature and catch of all species per unit effort and catch of all species (no. of fish), 1972-74, for 31-, 17-, and 12-wk survey periods, and significance at the .05 level.

Species		KENDALL		SPEARMAN		KENDALL	SPEARMAN	KENDALL	SPEARMAN
Block no.		SST /CPUE	SST /No. fish	SST /CPUE	SST /No. fish	SST /CPUE	SST /CPUE	SST /CPUE	SST /CPUE
		31 weeks				17 weeks		12 weeks	
Barracuda									
block 860									
1972	Corr.	.031	.310	.018	.424	.558	.746	.472	.628
	Sig. .05	No	No	No	Yes	Yes	Yes	No	Yes
1973	Corr.	.465	.607	.643	.796	.356	.498	.614	.769
	Sig. .05	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
1974	Corr.	.035	.173	.061	.263	.602	.792	.384	.518
	Sig. .05	No	No	No	No	Yes	Yes	No	No
Yellowtail									
block 916									
1972	Corr.	−.070	−.081	−.170	−.131	−.069	−.076	.453	.625
	Sig. .05	No	No	No	No	No	No	No	Yes
1973	Corr.	.100	.311	.159	.438	.164	.202	.605	.761
	Sig. .05	No	No	No	No	No	No	No	Yes
1974	Corr.	.208	.283	.280	.378	.390	.732	.837	.928
	Sig. .05	No	No	No	Yes	Yes	Yes	Yes	Yes
Bonito									
block 860									
1972	Corr.	−.102	.000	−.098	.043	.346	.582	.600	.771
	Sig. .05	No	No	No	No	No	No	No	No
1973	Corr.	.153	.363	.276	.537	.347	.505	.290	.518
	Sig. .05	No	Yes	No	Yes	No	Yes	No	No
1974	Corr.	.292	.481	.423	.646	.237	.313	.515	.699
	Sig. .05	No	Yes	Yes	Yes	No	No	No	Yes

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728. Vertical sections of semimonthly mean temperature on the San Francisco-Honolulu route: From expendable bathythermograph observations, June 1966–December 1974. By J. F. T. Saur, L. E. Eber, D. R. McLain, and C. E. Dorman. January 1979, iii + 35 p., 4 figs., 1 table.

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741. Distribution of gammaridean Amphipoda (Crustacea) in the Middle Atlantic Bight region. By John J. Dickinson, Roland L. Wigley, Richard D. Brodeur, and Susan Brown-Leger. October 1980, vi + 46 p., 26 figs., 52 tables.

742. Water structure at Ocean Weather Station V, northwestern Pacific Ocean, 1966-71. By D. M. Husby and G. R. Seckel. October 1980, 18 figs., 4 tables.

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746. Distribution of gammaridean Amphipoda (Crustacea) on Georges Bank, by John J. Dickinson and Roland L. Wigley. June 1981, iii + 25 p., 16 figs., 1 table.

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750. World literature to fish hybrids with an analysis by family, species, and hybrid: Supplement 1, by Frank J. Schwartz. November 1981, iii + 507 p.

751. The barge *Ocean 250* gasoline spill, by Carolyn A. Griswold (editor). November 1981, iv + 30 p., 28 figs., 17 tables.

752. Movements of tagged summer flounder, *Paralichthys dentatus*, off southern New England, by F. E. Lux and F. E. Nichy. December 1981, iii + 16 p., 13 figs., 3 tables.

753. Factors influencing ocean catches of salmon, *Oncorhynchus* spp., off Washington and Vancouver Island, by R. A. Low, Jr. and S. B. Mathews. January 1982, iv + 12 p., 6 figs., 7 tables.

NOAA Technical Report NMFS SSRF-760

Parasite-Host Records of Alaskan Fishes

Adam Moles

September 1982

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Parasite-Host Records of Alaskan Fishes

ADAM MOLES[1]

ABSTRACT

This report summarizes the published records of parasites of freshwater and coastal marine fishes of Alaska through 1980. The report is organized both by parasite and by host, is cross-referenced, and provides a convenient, single source of information on parasites of Alaskan fishes.

INTRODUCTION

References to parasites and their hosts for freshwater and coastal marine fishes of Alaska are scattered in dozens of published papers. This report provides a single source of published host-parasite records. Secondarily, it reveals host species for which little information on parasites exists.

I have attempted to include all formally published accounts (except collections from the high seas) of parasites of fish from Alaskan coastal or freshwaters through 1980. Most of these publications are from faunal surveys. The work of Jellison and Neiland (1965) was especially helpful in identifying some of the major pre-1960 work. I invite readers to call my attention to omissions.

For consistency in spelling, two references were used: Robins et al. (1980) and Margolis and Arthur (1979). No attempt has been made to unravel the complexities of parasite synonomy or to check the validity of published records. Scientific names have generally been left as the authors reported them unless most of the literature has clearly adopted a different name.

The report consists of two sections—parasite-host and host-parasite. In the parasite-host section, parasites are listed in the following order: Protozoa, Myxozoa, Monogenea, Trematoda, Cestoda, Nematoda, Acanthocephala, Hirudinea, Isopoda, Copepoda, and Mollusca (glochidia). Parasites within each group are listed alphabetically with the reported hosts for each parasite, with the appropriate reference. Only the first reported instance of each parasite-host relation is cited, and duplicate citations have been avoided except where a subsequent citation is more readily available or more complete. The adult and larval forms are listed separately for Trematoda, Cestoda, and Nematoda. Forms for which the life stage cannot be determined are listed with the adults. The host-parasite section lists parasites found on or in a given fish. The host families are organized phylogenetically after Robins et al. (1980). Within each family, genera are listed alphabetically. Larval forms of parasites are indicated by an asterisk (*) in the host listings.

---

[1] Northwest and Alaska Fisheries Center Auke Bay Laboratory, National Marine Fisheries Service, NOAA, P. O. Box 155, Auke Bay, AK 99821.

PARASITE-HOST LIST

Parasite	Host	Reference
	PROTOZOA	
Cryptobia sp.	*Cottus aleuticus*	Becker and Katz 1965
Eimeria clupearum (Thelohan 1894) Doflein 1909	*Clupea harengus pallasi*	Arthur and Arai 1980
Eimeria nishin Fujita 1934	*Clupea harengus pallasi*	Arthur and Arai 1980
	MYXOZOA (MYXOSPOREA)	
Ceratomyxa asymmetrica Moser and Noble 1976	*Coryphaenoides cinereus*	Moser and Noble 1976
Chloromyxum coregoni Bauer 1948	*Oncorhynchus nerka*	Konovalov 1971
Chloromyxum wardi Kudo 1920	*Oncorhynchus nerka*	Kudo 1920
Henneguya salminicola Ward 1919	*Oncorhynchus gorbuscha*	Fish 1939
	O. keta	Fish 1939
	O. kisutch	Fish 1939
	O. nerka	Fish 1939
	O. tshawytscha	Fish 1939
Kudoa sp.	*Hippoglossus stenolepis*	Patashnik and Groninger 1964
	Eopsetta jordani	Patashnik and Groninger 1964
	Microstomus pacificus	Patashnik and Groninger 1964
Myxobolus krokhini Konovalov and Shulman 1966	*Oncorhynchus nerka*	Konovalov 1971
Myxoproteus abyssus Yoshino and Moser 1974	*Coryphaenoides cinereus*	Yoshino and Moser 1974
	C. longifilis	Yoshino and Moser 1974
Ortholinea orientalis (Shulman and Shulman-Albova 1953)	*Clupea harengus pallasi*	Arthur and Arai 1980
Zschokkella meglitschi Moser and Noble 1977	*Coryphaenoides longifilis*	Moser and Noble 1977

Parasite	Host	Reference
MONOGENEA		
Acanthocotyle williamsi (Price 1938) Yamaguti 1963	*Raja* sp.	Price 1938
Benedenia derzhavini (Layman 1930) Meserve 1938	*Sebastes aleutianus*	Sekerak 1975
	S. alutus	Mamaev 1965
	S. zacentrus	Sekerak 1975
Cyclocotyloides pinguis (Linton 1940) Price 1943	*Coryphaenoides pectoralis*	McCauley and Smoker 1969
Dactylogyrid	*Thymallus arcticus*	Dunagan 1957
Entobdella hippoglossi (O. F. Muller 1776) Johnston 1856	*Hippoglossus stenolepis*	Price 1939
Gyrodactyloides strelkowi Bykhovskaya and Polyanskaya 1953	*Oncorhynchus nerka*	Pennell et al. 1973
Microcotyle sebastis Goto 1894	*Sebastes alutus*	Sekerak 1975
	S. zacentrus	Sekerak 1975
Squalonchotyle somniosi (Causey 1926)	*Somniosus pacificus*	Causey 1926
Tetraonchus alaskensis Price 1937	*Oncorhynchus kisutch*	Price 1937
	O. nerka	Margolis 1963
	Salmo clarki	Price 1937
	Salvelinus malma	Price 1937
Tetraonchus rauschi Mizelle and Webb 1953	*Thymallus arcticus*	Mizelle and Webb 1953
Tetraonchus variabilis (Mizelle 1953)	*Prosopium cylindraceum*	Mizelle and Webb 1953
Trochopus marginata (Folda 1928) Price 1936	*Sebastes ruberrimus*	Yamaguti 1963, Bonham 1950
	S. melanops	Bonham 1950
Trochopus sp.	*Sebastes aleutianus*	Sekerak 1975
	S. alutus	Sekerak 1975
	S. ciliatus	Sekerak 1975
	S. zacentrus	Sekerak 1975

Parasite	Host	Reference
	ADULT TREMATODA	
Aponurus argentini Polyanski 1952	*Merluccius productus*	Kovalenko 1970
Aporocotyle margolisi Smith 1967	*Merluccius productus*	Kovalenko 1970
Brachyphallus crenatus (Rudolphi 1802) Odhner 1905	*Clupea harengus pallasi*	Arthur and Arai 1980
	Oncorhynchus gorbuscha	Margolis 1957
	O. nerka	Margolis 1963
	O. tshawytscha	Riis 1974
	Osmerus mordax	Neiland 1962b
Bunodera luciopercae (Muller 1776) Luhe 1909	*Salvelinus alpinus*	Mudry and McCart 1976
Bunodera sp.	*Gasterosteus aculeatus*	Dunagan 1957
Crepidostomum farionis (Muller 1780) Luhe 1909	*Esox lucius*	Dunagan 1957
	Oncorhynchus nerka	Margolis 1963
	Salmo gairdneri	Dunagan 1957
	Salvelinus alpinus	Mudry and McCart 1976
	S. namaycush	Dunagan 1957
Crepidostomum isostomum Hopkins 1931	*Thymallus arcticus*	Dunagan 1957
Crepidostomum sp.	*Oncorhynchus nerka*	Neiland 1962a
	Salmo gairdneri	Neiland 1962a
	Salvelinus malma	Neiland 1962a
Derogenes macrostoma Yamaguti 1938	*Merluccius productus*	Kovalenko 1970
Derogenes varicus (Muller 1784) Looss 1901	*Hemilepidotus hemilepidotus*	Kruse 1977
	Hippoglossus stenolepis	Kruse 1977
	Lepidopsetta bilineata	Kruse 1977
	Lycodes palearis	Kruse 1977
	Merluccius productus	Kovalenko 1970
	Oncorhynchus gorbuscha	Margolis 1957
	O. nerka	Margolis 1963
	Ronquilus jordani	Kruse 1977
	Sebastes aleutianus	Sekerak 1975
	S. alutus	Sekerak 1975
	S. ciliatus	Sekerak 1975
	S. zacentrus	Sekerak 1975

Parasite	Host	Reference
Adult Trematoda (continued)		
Fellodistomum furcigerum (Olsson 1867) Yamaguti 1954	*Merluccius productus*	Kovalenko 1970
Fellodistomum sebastodis Yamaguti and Matumura 1942	*Sebastes alutus*	Sekerak 1975
	S. ciliatus	Sekerak 1975
	S. polyspinis	Sekerak 1975
Gonocerca oshoro Shimazu 1970	*Coryphaenoides pectoralis*	Shimazu 1970
Hemiurus levinseni Odhner 1905	*Boreogadus saida*	Dunagan 1957
	Oncorhynchus gorbuscha	Margolis 1957
	O. nerka	Margolis 1963
Lampritrema miescheri (Zschokke 1890) Margolis 1962	*Brama japonica*	Margolis 1962
Lecithaster gibbosus (Rudolphi 1802) Luhe 1901	*Clupea harengus pallasi*	Arthur and Arai 1980
	Oncorhynchus gorbuscha	Margolis 1957
	O. nerka	Margolis 1963
	Sebastes alutus	Mamaev 1965
Lecithochirium sp.	*Merluccius productus*	Kovalenko 1970
Lecithophyllum botryophorum (Olsson 1868) Odhner 1905	*Oncorhynchus gorbuscha*	Margolis 1957, 1958a
	O. nerka	Margolis 1963, 1958a
	Sebastes alutus	Sekerak 1975
	S. ciliatus	Sekerak 1975
Lecithophyllum spaerolecithum (Manter 1925) Odhner 1927	*Sebastes alutus*	Mamaev 1965
Neohelicometra sebastis Sekerak and Arai 1974	*Sebastes alutus*	Sekerak 1975
Neolepidapedon sebastisci (Yamaguti 1938) Manter 1954	*Sebastes aleutianus*	Sekerak 1975
	S. zacentrus	Sekerak 1975
Opechona alaskensis Ward and Fillingham 1934	*Porichthys notatus*	Ward and Fillingham 1934
	Sebastes alutus	Sekerak 1975, Mamaev 1965
	S. ciliatus	Sekerak 1975
	S. polyspinis	Sekerak 1975
	S. zacentrus	Sekerak 1975

Parasite	Host	Reference
Adult Trematoda (continued)		
Opechona occidentalis Montgomery 1957	*Sebastes ciliatus*	Sekerak 1975
Parahemiurus merus (Linton 1910) Woolcock 1935	*Oncorhynchus gorbuscha*	Margolis 1957
Peracreadium gasterostei (Dunagan 1957)	*Gasterosteus aculeatus*	Dunagan 1957
Phyllodistomum lysteri Miller 1940	*Dallia pectoralis*	Dunagan 1957
Phyllodistomum sp.	*Salvelinus alpinus* *Thymallus arcticus*	Mudry and McCart 1976 Dunagan 1957
Podocotyle atomon (Rudolphi 1802) Odhner 1905	*Sebastes alutus*	Mamaev 1965
Podocotyle reflexa (Creplin 1825) Odhner 1905	*Sebastes reflexa*	Mamaev 1965
Podocotyle sp.	*Sebastes aleutianus* *S. alutus* *S. ciliatus* *S. polyspinis* *S. zacentrus*	Sekerak 1975 Sekerak 1975 Sekerak 1975 Sekerak 1975 Sekerak 1975
Pronoprymna petrowi (Layman 1930) Bray and Gibson 1980	*Clupea harengus pallasi* *Oncorhynchus gorbuscha* *O. nerka*	Arthur and Arai 1980 Margolis and Ching 1965 Margolis and Ching 1965
Prosorhynchoides basargini (Layman 1930) Margolis and Arthur 1978	*Oncorhynchus gorbuscha* *O. nerka*	Margolis 1957 Margolis 1963
Prosorhynchoides sp.	*Osmerus mordax*	Neiland 1962b as *Bucephalopsis* sp.
Prosorhynchus crucibulum (Rudolphi 1819) Odhner 1905	*Sebastes aleutianus* *S. alutus* *S. ciliatus* *S. zacentrus*	Sekerak 1975 Sekerak 1975 Sekerak 1975 Sekerak 1975
Prosorhynchus mizelli Kruse 1977	*Aptocyclus ventricosus*	Kruse 1977

Parasite	Host	Reference
Adult Trematoda (continued)		
Psettarium sebastodorum Holmes 1971	*Sebastes alutus*	Sekerak 1975
	S. polyspinis	Sekerak 1975
	S. zacentrus	Sekerak 1975
Pseudopecoelus nossamani Kruse 1977	*Hippoglossus stenolepis*	Kruse 1977
Stephanostomum californicum Manter and Van Cleave 1951	*Anoplopoma fimbria*	Kovalenko 1970
Stephanostomum dentatum (Linton 1900) Linton 1940	*Sebastes aleutianus*	Sekerak 1975
Tubulovesicula lindbergi (Layman 1930) Yamaguti 1934	*Oncorhynchus gorbuscha*	Margolis 1957
	O. nerka	Margolis 1963
Urinatrema aspinosum Schiller 1956	*Hexagrammos lagocephalus*	Schiller 1956
	LARVAL TREMATODA	
Diplostomulum sp.	*Oncorhynchus nerka*	Margolis 1957
Nanophyetus salmincola Chapin 1926	*Oncorhynchus* sp.	Farrell 1964
Prosorhynchoides basargini (Layman 1930) Margolis and Arthur 1978	*Clupea harengus pallasi*	Arthur and Arai 1980
Prosorhynchus sp.	*Hemilepidotus hemilepidotus*	Kruse 1977
Rhipidocotyle sp.	*Clupea harengus pallasi*	Arthur and Arai 1980
Stephanostomum sp.	*Atheresthes stomias*	Kovalenko 1969
Tetracotyle sp.	*Oncorhynchus gorbuscha*	Margolis 1957
	O. nerka	Margolis 1963
	ADULT CESTODA	
Bothrimonus sturionis Duvernoy 1842	*Coregonus* sp.	
	Oncorhynchus gorbuscha	Burt and Sandeman 1969
	O. nerka	Margolis 1963
	Salvelinus alpinus	Mudry and McCart 1976
	S. malma	Cooper 1921

Parasite	Host	Reference
Adult Cestoda (continued)		
Bothriocephalus ospariichthydis Yamaguti 1934	Merluccius productus	Kovalenko 1970
Bothriocephalus scorpii (O. F. Muller 1776) Rudolphi 1808	Sebastes alutus	Mamaev 1965
Cyathocephalus truncatus (Pallas 1781) Kessler 1868	Esox lucius	Dunagan 1957
	Oncorhynchus kisutch	Riis 1974
	Salvelinus alpinus	Mudry and McCart 1976
	S. namaycush	Dunagan 1957
Diplocotyle olrikii Krabbe 1874	Oncorhynchus gorbuscha	Margolis 1957
	O. nerka	Margolis 1963
Eubothrium crassum (Bloch 1779) Nybelin 1922	Salmo gairdneri	Dunagan 1957
	Salvelinus alpinus	Mudry and McCart 1976
Eubothrium salvelini (Schrank 1790) Nybelin 1922	Oncorhynchus gorbuscha	Margolis 1957
	O. nerka	Pennell et al. 1973
Eubothrium sp.	Oncorhynchus kisutch	Riis 1974
	O. nerka	Margolis 1963
	O. tshawytscha	Riis 1974
	Salmo gairdneri	Riis 1974
	Salvelinus malma	Riis 1974
Glaridacris catostomi Cooper 1920	Catostomus commersoni	Dunagan 1957
Monorygma perfectum (Van Beneden 1853)	Somniosus pacificus	Linton 1924
Nybelinia surmenicola Okada in Dollfus 1929	Lamna ditropis	Shimazu 1975
Pedibothrium pinguicollum (Sleggs 1927) Price 1938	Raja sp.	Price 1938
Proteocephalus filicollis (Rudolphi 1802) Weinland 1858	Prosopium cylindraceum	Dunagan 1957

Parasite	Host	Reference
Adult Cestoda (continued)		
Proteocephalus sp.	Dallia pectoralis	Dunagan 1957
	Oncorhynchus kisutch	Riis 1974
	O. nerka	Pennell et al. 1973
	Prosopium cylindraceum	Riis 1974
	Salmo gairdneri	Riis 1974
	Salvelinus alpinus	Mudry and McCart 1976
	S. malma	Riis 1974
	Thymallus arcticus	Riis 1974
Triaenophorus crassus Forel 1868	Esox lucius	Dunagan 1957
	Salvelinus namaycush	Dunagan 1957
	LARVAL CESTODA	
Bothriocephalus scorpii (Muller 1776) Rudolphi 1808	Sebastes alutus	Sekerak 1975
	S. zacentrus	Sekerak 1975
Bothriocephalus sp.	Merluccius productus	Kovalenko 1970
Diphyllobothrium dalliae Rausch 1956	Dallia pectoralis	Rausch 1956
Diphyllobothrium dendriticum (Nitzsch 1824) Luhe 1910	Salmo gairdneri	Hilliard 1960
Diphyllobothrium osmeri (Von Linstow 1878)	Osmerus mordax	Hilliard 1960
Diphyllobothrium phocarum (Fabricius 1780)	Eleginus gracilis	Hilliard 1960
Diphyllobothrium ursi Rausch 1954	Oncorhynchus nerka	Rausch 1954, Hilliard 1960
Diphyllobothrium sp.	Dallia pectoralis	Colyar 1963
	Merluccius productus	Kovalenko 1970
	Oncorhynchus nerka	Margolis 1963
	Pungitius pungitius	Colyar 1963
	Salmo gairdneri	Babero and Rausch 1953, Needham and Behnke 1965
Ligula intestinalis (Linn. 1758) Gmelin 1790	Salmo gairdneri	Dunagan 1957

Parasite	Host	Reference
Larval Cestoda (continued)		
Nybelinia surmenicola (Okada in Dollfus 1929)	*Anoplopoma fimbria*	Kovalenko 1970
	Atheresthes stomias	Kovalenko 1969
	Clupea harengus pallasi	Arthur and Arai 1980
	Hexanchus griseus	Hart 1936
	Merluccius productus	Kovalenko 1970
	Oncorhynchus nerka	Margolis 1957
	Sebastes aleutianus	Sekerak 1975
	S. alutus	Sekerak 1975
	S. ciliatus	Sekerak 1975
	S. polyspinis	Sekerak 1975
	S. zacentrus	Sekerak 1975
Nybelinia sp.	*Theragra chalcogramma*	Akmerov 1951
Phyllobothrium caudatum (Zschokke and Heitz 1914) Zmeev 1936	*Oncorhynchus gorbuscha*	Margolis 1957
	O. keta	Canavan 1928
	O. nerka	Margolis 1963
Phyllobothrium sp.	*Oncorhynchus gorbuscha*	Riis 1974
	O. keta	Riis 1974
	O. kisutch	Riis 1974
	O. nerka	Riis 1974
	O. tshawytscha	Riis 1974
	Sebastes aleutianus	Sekerak 1975
	S. alutus	Sekerak 1975
	S. ciliatus	Sekerak 1975
	S. polyspinis	Sekerak 1975
	S. zacentrus	Sekerak 1975
Proteocephalus sp.	*Oncorhynchus nerka*	Margolis 1963
Schistocephalus solidus (Muller 1776) Steenstrup 1857	*Gasterosteus aculeatus*	Cooper 1918, Hilliard 1960, Valdez 1974
	Pungitius pungitius	Hilliard 1960
Scolex pleuronectis Muller 1788	*Clupea harengus pallasi*	Arthur and Arai 1980
	Sebastes alutus	Mamaev 1965
Scolex sp.	*Anoplopoma fimbria*	Kovalenko 1970
	Merluccius productus	Kovalenko 1970
Tetrarhynchus sp.	*Hexanchus griseus*	Hart 1936
Triaenophorus crassus Forel 1868	*Oncorhynchus keta*	Uzmann and Hesselholt 1957
	O. nerka	Margolis 1963
	Thymallus arcticus	Dunagan 1957
Triaenophorus sp.	*Dallia pectoralis*	Hilliard 1960

Parasite	Host	Reference
	ADULT NEMATODA	
Ascarophis pacificus Zhukov 1960	*Sebastes alutus*	Mamaev 1965
Ascarophis sp.	*Oncorhynchus gorbuscha*	Margolis 1957
Capillaria sp.	*Oncorhynchus nerka*	Margolis 1963
Cucullanus heterochrous Rudolphi 1802	*Sebastes alutus*	Mamaev 1965
Cucullanus sp.	*Oncorhynchus tshawytscha*	Riis 1974
	Salmo gairdneri	Riis 1974
	Sebastes aleutianus	Sekerak 1975
	S. alutus	Sekerak 1975
	Thymallus arcticus	Sekerak 1975
Cystidicola farionis Fischer 1798	*Oncorhynchus gorbuscha*	Margolis 1967
	O. nerka	Margolis 1967
	Salvelinus alpinus	Pennell et al. 1973
	S. malma	Ko and Anderson 1969
	S. namaycush	Dunagan 1957
Hysterothylacium aduncum (Rudolphi 1802)	*Merluccius productus*	Kovalenko 1970
	Sebastes aleutianus	Kovalenko 1970
	S. alutus	Sekerak 1975
	S. ciliatus	Sekerak 1975
	S. polyspinis	Sekerak 1975
	S. zacentrus	Sekerak 1975
Hysterothylacium melanogrammi (Smedley 1934) Seardorff and Overstreet 1981	*Merluccius productus*	Kovalenko 1970
Philonema oncorhynchi Kuitunen-Ekbaum 1933	*Oncorhynchus gorbuscha*	Margolis 1957
	O. nerka	Margolis 1963, Dunagan 1957
Rhabdochona sp.	*Oncorhynchus nerka*	Pennell et al. 1973
Salvelinema salmonicola (Ishii 1916) Margolis 1966	*Oncorhynchus nerka*	Margolis 1967
Truttaedacnitis alpinus (Mudry and McCart 1974) Pybus, Anderson, and Uhazy 1978	*Salvelinus alpinus*	Mudry and McCart 1974

Parasite	Host	Reference
	LARVAL NEMATODA	
Anisakis simplex (Rudolphi 1809) Dujardin 1845	*Clupea harengus pallasi*	Arthur and Arai 1980
Anisakis sp.	*Dallia pectoralis*	Dunagan 1957
	Gadus macrocephalus	Stiles and Hassall 1899
	Merluccius productus	Kovalenko 1970
	Oncorhynchus gorbuscha	Margolis 1957
	O. keta	Riis 1974
	O. kisutch	Riis 1974
	O. nerka	Pennell et al. 1973
	O. tshawytscha	Riis 1974
	Theragra chalcogramma	Stiles and Hassall 1899, Scheffer and Slipp 1944
	Thymallus arcticus	Dunagan 1957
Contracaecum rudolphii Hartwich 1964	*Salmo gairdneri*	Riis 1974
Contracaecum sp.	*Anoplopoma fimbria*	Kovalenko 1970
	Atheresthes stomias	Kovalenko 1969
	Boreogadus saida	Dunagan 1957
	Clupea harengus pallasi	Arthur and Arai 1980
	Gasterosteus aculeatus	Dunagan 1957
	Merluccius productus	Kovalenko 1970
	Oncorhynchus gorbuscha	Margolis 1957
	O. nerka	Margolis 1963
	Sebastes aleutianus	Sekerak 1975
	S. alutus	Sekerak 1975
	S. ciliatus	Sekerak 1975
	S. polyspinis	Sekerak 1975
	S. zacentrus	Sekerak 1975
	Stenobrachius leucopsarus	Collard 1968
Hysterothylacium aduncum (Rudolphi 1802)	*Boreogadus saida*	Dunagan 1957
	Clupea harengus pallasi	Arthur and Arai 1980
Philonema oncorhynchi Kuitunen-Ekbaum 1933	*Oncorhynchus kisutch*	Riis 1974
	Salmo gairdneri	Riis 1974
Philonema sp.	*Salmo gairdneri*	Needham and Behnke 1965

Parasite	Host	Reference
Larval Nematoda (continued)		
Phocanema decipiens (Krabbe 1878) Myers 1959	*Gadus macrocephalus*	Scheffer and Slipp 1944
	Hemilepidotus hemilepidotus	Schiller 1954
	Hexagrammos lagocephalus	Rausch 1953, Schiller 1954
	Oncorhynchus nerka	Margolis 1963
Phocanema sp.	*Anaplopoma fimbria*	Kovalenko 1970
	Atheresthes stomias	Kovalenko 1969
	Oncorhynchus nerka	Margolis 1957
	O. tshawytscha	Riis 1974
	Osmerus mordax	Hilliard 1960
Raphidascaris sp.	*Dallia pectoralis*	Dunagan 1957
	Esox lucius	Dunagan 1957
	Oncorhynchus tshawytscha	Riis 1974
	Salvelinus namaycush	Riis 1974 Neiland 1962a
	ACANTHOCEPHALA	
Acanthocephalus lucii (Muller 1776) Luhe 1911	*Gasterosteus aculeatus*	Dunagan 1957
Bolbosoma caenoforme (Heitz 1920) Meyer 1933	*Oncorhynchus nerka*	Pennell et al. 1973, Margolis 1963
	Sebastes alutus	Mamaev 1965
Bolbosoma sp.	*Oncorhynchus gorbuscha*	Margolis 1957
Corynosoma hadweni Van Cleave 1953	*Oncorhynchus nerka*	Margolis 1958b
	Osmerus mordax	Golvan 1959
Corynosoma reductum Von Lindstow 1905	*Sebastes alutus*	Mamaev 1965
Corynosoma semerme (Forssell 1904)	*Oncorhynchus nerka*	Margolis 1958b
	Osmerus mordax	Neiland 1962b
Corynosoma similis Neiland 1962	*Osmerus mordax*	Neiland 1962b
Corynosoma strumosum (Rudolphi 1802) Luhe 1904	*Atheresthes stomias*	Kovalenko 1969
	Clupea harengus pallasi	Arthur and Arai 1980
	Oncorhynchus gorbuscha	Margolis 1957, 1958b
	O. nerka	Margolis 1958b
	Osmerus mordax	Neiland 1962b

Parasite	Host	Reference
Acanthocephala (continued)		
Corynosoma villosum (Van Cleave 1953)	*Clupea harengus pallasi*	Arthur and Arai 1980
	Oncorhynchus gorbuscha	Margolis 1957, 1958b
	O. nerka	Margolis 1963
Corynosoma sp.	*Anoplopoma fimbria*	Kovalenko 1970
	Boreogadus saida	Dunagan 1957
	Hexagrammos lagocephalus	Schiller 1954
	Hemilepidotus hemilepidotus	Schiller 1954
	Oncorhynchus gorbuscha	Margolis 1957
	Sebastes aleutianus	Sekerak 1975
	S. alutus	Sekerak 1975
	S. ciliatus	Sekerak 1975
	S. zacentrus	Sekerak 1975
Echinorhynchus gadi (Muller 1776)	*Boreogadus saida*	Dunagan 1957
	Oncorhynchus gorbuscha	Margolis 1957
	O. nerka	Margolis 1963
	Sebastes aleutianus	Sekerak 1975
	S. alutus	Sekerak 1975
	S. zacentrus	Sekerak 1975
Echinorhynchus sp.	*Atheresthes stomias*	Kovalenko 1969
Metechinorhynchus salmonis (Muller 1784) Petrochenko 1956	*Boreogadus saida*	Dunagan 1957
	Salvelinus alpinus	Mudry and McCart 1976
Neoechinorhynchus rutili (Muller 1780) Hamann 1892	*Coregonus sardinella*	Schmidt 1965
	Dallia pectoralis	Dunagan 1957
	Gasterosteus aculeatus	Van Cleave and Lynch 1950
	Lota lota	Schmidt 1965
	Oncorhynchus kisutch	Riis 1974
	O. nerka	Margolis 1963
	Salmo gairdneri	Riis 1974
	Salvelinus alpinus	Van Cleave and Lynch 1950
	S. malma	Van Cleave and Lynch 1950
Neoechinorhynchus tenellus (Van Cleave 1913) Van Cleave 1919	*Esox lucius*	Dunagan 1957
Neoechinorhynchus tumidus Van Cleave and Bangham 1949	*Coregonus laurettae*	Schmidt 1965
	C. nasus	Schmidt 1965
	Coregonus sp.	Schmidt 1965
	Oncorhynchus kisutch	Riis 1974
	Prosopium cylindraceum	Schmidt 1965
	Salmo gairdneri	Schmidt 1965

Parasite	Host	Reference
Acanthocephala (continued)		
Neoechinorhynchus sp.	Oncorhynchus gorbuscha	Margolis 1957
Paracanthocephalus rauschi Schmidt 1969	Thymallus arcticus	Schmidt 1969
Rhadinorhynchus cololabris Laurs and McCauley 1964	Salmo gairdneri	Hughes 1973
Rhadinorhynchus trachuri Harada 1935	Oncorhynchus nerka	Margolis 1957
	HIRUDINEA	
Levinsenia rectangulata (Levinson 1882)	Gadus macrocephalus Microgadus proximus Myoxocephalus polyacanthocephalus Theragra chalcogramma	Moore and Meyer 1951 Moore and Meyer 1951 Moore and Meyer 1951 Akhmerov 1951
	ISOPODA	
Aega symmetrica Richardson	Unnamed fish	Hatch 1947
Livoneca californica Schioedte and Meinertz 1884	Smelt	Hatch 1947
Rocinela angustata Richardson	Hippoglossus stenolepis	Hatch 1947
Rocinela belliceps (Stimpson 1864) Richardson 1899	Gadus macrocephalus Hippoglossus stenolepis	Hatch 1947 Hatch 1947
	COPEPODA	
Acanthochondria cornuta (Muller 1776) Oakley 1930	Hippoglossus stenolepis	Wilson 1935
Acanthochondria sp.	Merluccius productus	Kovalenko 1970
Bomolochus cuneatus Fraser 1920	Clupea harengus pallasi Oncorhynchus gorbuscha	Arthur and Arai 1980 Vervoort 1964

Parasite	Host	Reference
Copepoda (continued)		
Brachiella robusta (Wilson 1912) Kabata 1970	Sebastes aleutianus	Sekerak 1975
	S. alutus	Sekerak 1975
	S. ciliatus	Sekerak 1975
	S. zacentrus	Sekerak 1975
Caligus clemensi Parker and Margolis 1964	Clupea harengus pallasi	Arthur and Arai 1980
Chondracanthus lotellae (Wilson 1936) Yamaguti 1963	Myoxocephalus polyacanthocephalus	Wilson 1935
Chondracanthus pinguis Wilson 1912	Sebastes aleutianus	Sekerak 1975
	S. alutus	Sekerak 1975
	S. ciliatus	Sekerak 1975
	S. polyspinis	Sekerak 1975
	S. zacentrus	Sekerak 1975
Chondracanthus triventricosus Sekerak 1970	Sebastes alutus	Sekerak 1975
	S. ciliatus	Sekerak 1975
	S. polyspinis	Sekerak 1975
	S. zacentrus	Sekerak 1975
Clavella adunca (Strøm 1762) Dollfus 1953	Gadus macrocephalus	Wilson 1908
	Theragra chalcogramma	Akhmerov 1951
Clavella canaliculata Wilson 1915	Microgadus proximus	Wilson 1915, 1920
Clavella irina Wilson 1915	Gadus macrocephalus	Wilson 1915, 1920
Clavella parva Wilson 1912	Sebastes aleutianus	Sekerak 1975
	S. alutus	Sekerak 1975
	S. melanops	Sekerak 1975
Clavella perfida Wilson 1915	Theragra chalcogramma	Wilson 1915
Clavella recta Wilson 1915	Sebastes melanops	Wilson 1915, 1920
Colobomatus kyphosus Sekerak 1970	Sebastes aleutianus	Sekerak 1975
	S. alutus	Sekerak 1975
	S. ciliatus	Sekerak 1975
	S. polyspinis	Sekerak 1975
	S. zacentrus	Sekerak 1975

Parasite	Host	Reference
Copepoda (continued)		
Diocus frigidus (Hansen 1923)	Lycodes turneri	Walters 1953
Echthrogaleus coleoptratus (Guerin 1837) Steenstrup and Lutken 1861	"Shark"	Wilson 1907, 1908, 1920
Ergasilus auritus Markevich 1940	Gasterosteus aculeatus	Roberts 1963
	Oncorhynchus nerka	Roberts 1963
Ergasilus turgidus Fraser 1920	Gasterosteus aculeatus	Cope 1959
	Oncorhynchus nerka	Cope 1959
Haemobaphes theragrae Yamaguti 1939	Sebastes alutus	Sekerak 1975
	S. zacentrus	Sekerak 1975
Haemobaphes sp.	Merluccius productus	Kovalenko 1970
Lepeophtheirus appendiculatus Krøyer 1863	Hippoglossus stenolepis	Wilson 1935
Lepeophtheirus cuneifer Kabata 1974	Gadus macrocephalus	Kabata 1974
	Hexagrammos lagocephalus	Kabata 1974
	Hippoglossus stenolepis	Kabata 1974
	Isopsetta isolepis	Kabata 1974
	Leptocottus armatus	Kabata 1974
	Lumpenus sagitta	Kabata 1974
	Microgadus proximus	Kabata 1974
	Raja binoculata	Kabata 1974
	Squalus acanthias	Kabata 1974
	Theragra chalcogramma	Kabata 1974
Lepeophtheirus marcepes Wilson 1944	Pleuronectes quadrituberculatus	Wilson 1944
Lepeophtheirus parviventris Wilson 1905	Gadus macrocephalus	Wilson 1905
	Hippoglossus stenolepis	Wilson 1905
	Lepidopsetta bilineata	Wilson 1905
	Platichthys stellatus	Townsend 1938
	Pleurogrammus monopterygius	Wilson 1908
Lepeophtheirus salmonis (Krøyer 1837) Verrill 1873	Oncorhynchus gorbuscha	Wilson 1905
	O. nerka	Wilson 1908
	O. tshawytscha	Wilson 1908
	Salvelinus malma	Wilson 1908
Naobranchia occidentalis Wilson 1915	Gadus macrocephalus	Wilson 1915

Parasite	Host	Reference
Copepoda (continued)		
Parabrachiella sp.	Merluccius productus	Kovalenko 1970
Salmincola californiensis (Dana 1852) Wilson 1915	Oncorhynchus gorbuscha	Wilson 1908
	O. kisutch	Riis 1974
	O. nerka	Wilson 1908, Margolis 1963
	Salmo gairdneri	Riis 1974
Salmincola carpionis (Krøyer 1837) Wilson 1915	Salvelinus alpinus	Mudry and McCart 1976
	S. malma	Wilson 1908
Salmincola edwardsi (Olsson 1869) Wilson 1915	Salmo gairdneri	Dunagan 1957
	Salvelinus alpinus	Dunagan 1957
	Thymallus arcticus	Dunagan 1957
Salmincola extensus (Kessler 1868) Kabata 1969	Coregonus sp.	Wilson 1908
Salmincola extumescens (Gadd 1901) Wilson 1915	Coregonus clupeaformis	Wilson 1908
Salmincola thymalli (Kessler 1868) Wilson 1915	Prosopium cylindraceum	Riis 1974
	Thymallus arcticus	Riis 1974
Sarcotaces arcticus Collett 1874	Sebastes aleutianus	Sekerak 1975
	S. alutus	Sekerak 1975
	S. flavidus	Avdeev and Avdeev 1975
Thersitina gasterostei (Pagenstecher 1861) Norman 1905	Gasterosteus aculeatus	Valdez 1974
	MOLLUSCA	
Anodonta beringiana (Middendorf)	Gasterosteus aculeatus	Cope 1959
	Oncorhynchus nerka	Cope 1959
Anodonta oregonensis (Lea 1837)	Gasterosteus aculeatus	Moles 1980
	Oncorhynchus kisutch	Moles 1980

HOST-PARASITE LIST

HEXANCHIDAE, cow sharks

- _Hexanchus griseus_ (Bonnaterre), sixgill shark
  - Cestoda
    - _Nybelinia surmenicola_*
    - _Tetrahynchus_ sp.*

LAMNIDAE, mackerel sharks

- _Lamna ditropis_ Hubbs and Follett, salmon shark
  - Cestoda
    - _Nybelinia surmenicola_

SQUALIDAE, dogfish sharks

- _Somniosus pacificus_ Bigelow and Schroeder, Pacific sleeper shark
  - Monogenea
    - _Squalonchotyle somniosi_
  - Cestoda
    - _Monorygma perfectum_
- _Squalus acanthias_ Linnaeus, spiny dogfish
  - Copepoda
    - _Lepeophtheirus cuneifer_

RAJIDAE, skates

- _Raja binoculata_ Girard, big skate
  - Copepoda
    - _Lepeophtheirus cuneifer_
- _Raja_ sp.
  - Monogenea
    - _Acanthocotyle williamsi_
  - Cestoda
    - _Pedibothrium pinguicollum_

CLUPEIDAE, herring

- _Clupea harengus pallasi_ Valenciennes, Pacific herring
  - Protozoa
    - _Eimeria clupearum_
    - _Eimeria nishin_
  - Myxospora
    - _Ortholinea orientalis_

Clupeidae, _Clupea harengus pallasi_ (continued)

- Trematoda
  - _Brachyphallus crenatus_
  - _Lecithaster gibbosus_
  - _Prosorhynchoides basargini_*
  - _Pronoprymna petrowi_
  - _Rhipidocotyle_ sp.*
- Cestoda
  - _Nybelinia surmenicola_*
  - _Scolex pleuronectis_*
- Nematoda
  - _Anisakis simplex_*
  - _Contracaecum_ sp.*
  - _Hysterothylacium aduncum_*
- Acanthocephala
  - _Corynosoma strumosum_
  - _Corynosoma villosum_
- Copepoda
  - _Bomolochus cuneatus_
  - _Caligus clemensi_

SALMONIDAE, trouts

Coregonus clupeaformis (Mitchill), lake whitefish

- Copepoda
  - _Salmincola extumescens_

Coregonus laurettae Bean, Bering cisco

- Acanthocephala
  - _Neoechinorhynchus tumidus_

Coregonus nasus (Pallas), broad whitefish

- Acanthocephala
  - _Neoechinorhynchus tumidus_

Coregonus sardinella Valenciennes, least cisco

- Acanthocephala
  - _Neoechinorhynchus rutili_

Coregonus sp.

- Cestoda
  - _Bothrimonus sturionis_
- Acanthocephala
  - _Neoechinorhynchus tumidus_
- Copepoda
  - _Salmincola extensus_

Salmonidae (continued)

Oncorhynchus gorbuscha (Walbaum), pink salmon

- Myxozoa
  - *Henneguya salminicola*
- Trematoda
  - *Brachyphallus crenatus*
  - *Derogenes varicus*
  - *Hemiurus levinseni*
  - *Lecithaster gibbosus*
  - *Lecithophyllum botryophorum*
  - *Parahemiurus merus*
  - *Prosorhynchoides basargini*
  - *Pronoprymna petrowi*
  - *Tetracotyle* sp.
  - *Tubulovesicula lindbergi*
- Cestoda
  - *Bothrimonus sturionis*
  - *Diplocotyle olrikii*
  - *Eubothrium salvelini*
  - *Phyllobothrium caudatum**
  - *Phyllobothrium* sp.*
- Nematoda
  - *Anisakis* sp.*
  - *Ascarophis* sp.
  - *Contracaecum* sp.*
  - *Cystidicola farionis*
  - *Philonema oncorhynchi*
- Acanthocephala
  - *Bolbosoma* sp.
  - *Corynosoma* sp.
  - *Corynosoma strumosum*
  - *Corynosoma villosum*
  - *Echinorhynchus gadi*
  - *Neoechinorhynchus* sp.
- Copepoda
  - *Bomolochus cuneatus*
  - *Lepeophtheirus salmonis*
  - *Salmincola californiensis*

Oncorhynchus keta (Walbaum), chum salmon

- Myxozoa
  - *Henneguya salminicola*
- Cestoda
  - *Phyllobothrium caudatum**
  - *Phyllobothrium* sp.*
  - *Triaenophorus crassus**
- Nematoda
  - *Anisakis* sp.*

Salmonidae (continued)

Oncorhynchus kisutch (Walbaum), coho salmon

- Myxozoa
  - *Henneguya salminicola*
- Monogenea
  - *Tetraonchus alaskensis*
- Cestoda
  - *Cyathocephalus truncatus*
  - *Eubothrium* sp.
  - *Phyllobothrium* sp.*
  - *Proteocephalus* sp.
- Nematoda
  - *Anisakis* sp.*
  - *Philonema oncorhynchi**
- Acanthocephala
  - *Neoechinorhynchus rutili*
  - *Neoechinorhynchus tumidus*
- Copepoda
  - *Salmincola californiensis*
- Mollusca
  - *Anodonta oregonensis*

Oncorhynchus nerka (Walbaum), sockeye salmon

- Myxozoa
  - *Chloromyxum wardi*
  - *C. coregoni*
  - *Henneguya salminicola*
  - *Myxobolus krokhini*
- Monogenea
  - *Gyrodactyloides strelkowi*
  - *Tetraonchus alaskensis*
- Trematoda
  - *Brachyphallus crenatus*
  - *Crepidostomum farionis*
  - *Crepidostomum* sp.
  - *Derogenes varicus*
  - *Diplostomulum* sp.*
  - *Hemiurus levinseni*
  - *Lecithaster gibbosus*
  - *Lecithophyllum botryophorum*
  - *Prosorhynchoides basargini*
  - *Pronoprymna petrowi*
  - *Tetracotyle* sp.*
  - *Tubulovesicula lindbergi*

Salmonidae, *Oncorhynchus nerka* (continued)

- Cestoda
  - *Bothrimonus sturionis*
  - *Diphyllobothrium* sp.*
  - *Diphyllobothrium ursi**
  - *Diplocotyle olrikii*
  - *Eubothrium salvelini*
  - *Eubothrium* sp.
  - *Nybelinia surmenicola**
  - *Phyllobothrium caudatum**
  - *Phyllobothrium* sp.*
  - *Proteocephalus* sp.
  - *Proteocephalus* sp.*
  - *Triaenophorus crassus**
- Nematoda
  - *Anisakis* sp.*
  - *Capillaria* sp.
  - *Contracaecum* sp.*
  - *Cystidicola farionis*
  - *Philonema oncorhynchi*
  - *Phocanema decipiens**
  - *Phocanema* sp.*
  - *Rhabdochona* sp.
  - *Salvelinema salmonicola*
- Acanthocephala
  - *Bolbosoma caenoforme*
  - *Corynosoma hadweni*
  - *Corynosoma semerme*
  - *Corynosoma strumosum*
  - *Corynosoma villosum*
  - *Echinorhynchus gadi*
  - *Neoechinorhynchus rutili*
  - *Rhadinorhynchus trachuri*
- Copepoda
  - *Ergasilus auritus*
  - *Ergasilus turgidus*
  - *Lepeophtheirus salmonis*
  - *Salmincola californiensis*
- Mollusca
  - *Anodonta beringiana*

Oncorhynchus tshawytscha (Walbaum), chinook salmon

- Myxozoa
  - *Henneguya salminicola*
- Trematoda
  - *Brachyphallus crenatus*
- Cestoda
  - *Eubothrium* sp.
  - *Phyllobothrium* sp.*

Salmonidae, *Oncorhynchus tschawytscha* (continued)

- Nematoda
  - *Anisakis* sp.*
  - *Cucullanus* sp.*
  - *Phocanema* sp.*
  - *Raphidascaris* sp.*
- Copepoda
  - *Lepeophtheirus salmonis*

Oncorhynchus sp.

- Trematoda
  - *Nanophyetus salmincola**

Prosopium cylindracaeum (Pallas), round whitefish

- Monogenea
  - *Tetraonchus variabilis*
- Cestoda
  - *Proteocephalus filicollis*
  - *Proteocephalus* sp.
- Acanthocephala
  - *Neoechinorhynchus tumidus*
- Copepoda
  - *Salmincola thymalli*

Salmo clarki Richardson, cutthroat trout

- Monogenea
  - *Tetraonchus alaskensis*

Salmo gairdneri Richardson, rainbow trout

- Trematoda
  - *Crepidostomum farionis*
  - *Crepidostomum* sp.
- Cestoda
  - *Diphyllobothrium dendriticum**
  - *Diphyllobothrium* sp.*
  - *Eubothrium crassum*
  - *Eubothrium* sp.
  - *Ligula intestinalis**
  - *Proteocephalus* sp.
- Nematoda
  - *Contracaecum rudolphii**
  - *Cucullanus* sp.
  - *Philonema oncorhynchi**
  - *Philonema* sp.*
- Acanthocephala
  - *Neoechinorhynchus rutili*
  - *Neoechinorhynchus tumidus*
  - *Rhadinorhynchus cololabris*

Salmonidae, *Salmo gairdneri* (continued)

- Copepoda
    - *Salmincola californiensis*
    - *Salmincola edwardsi*

Salvelinus alpinus (Linnaeus), Arctic char

- Trematoda
    - *Bunodera luciopercae*
    - *Crepidostomum farionis*
    - *Phyllodistomum* sp.
- Cestoda
    - *Bothrimonus sturionis*
    - *Cyathocephalus truncatus*
    - *Eubothrium crassum*
    - *Proteocephalus* sp.
- Nematoda
    - *Cystidicola farionis*
    - *Truttaedacnitis alpinis*
- Acanthocephala
    - *Metechinorhynchus salmonis*
    - *Neoechinorhynchus rutili*
- Copepoda
    - *Salmincola carpionis*
    - *Salmincola edwardsi*

Salvelinus malma (Walbaum), Dolly Varden

- Monogenea
    - *Tetraonchus alaskensis*
- Trematoda
    - *Crepidostomum* sp.
- Cestoda
    - *Bothrimonus sturionis*
    - *Eubothrium* sp.
    - *Proteocephalus* sp.
- Nematoda
    - *Cystidicola farionis*
- Acanthocephala
    - *Neoechinorhynchus rutili*
- Copepoda
    - *Lepeophtheirus salmonis*
    - *Salmincola carpionis*

Salvelinus namaycush (Walbaum), lake trout

- Trematoda
    - *Crepidostomum farionis*
- Cestoda
    - *Cyathocephalus truncatus*
    - *Triaenophorus crassus*
- Nematoda
    - *Cystidicola farionis*
    - *Raphidascaris* sp.*

Salmonidae (continued)

Thymallus arcticus (Pallas), Arctic grayling

- Monogenea
    - *Tetraonchus rauschi*
- Trematoda
    - *Crepidostomum isostomum*
    - *Phyllodistomum* sp.
- Cestoda
    - *Proteocephalus* sp.
    - *Triaenophorus crassus**
- Nematoda
    - *Anisakis* sp.*
    - *Cucullanus* sp.
- Acanthocephala
    - *Paracanthocephalus rauschi*
- Copepoda
    - *Salmincola edwardsi*
    - *S. thymalli*

OSMERIDAE, smelts

Osmerus mordax (Mitchill), rainbow smelt

- Trematoda
    - *Brachyphallus crenatus*
    - *Prosorhynchoides* sp.
- Cestoda
    - *Diphyllobothrium osmeri**
- Nematoda
    - *Phocanema* sp.*
- Acanthocephala
    - *Corynosoma hadweni*
    - *C. semerme*
    - *C. similis*
    - *C. strumosum*

UMBRIDAE, mudminnows

Dallia pectoralis Bean, Alaska blackfish

- Trematoda
    - *Phyllodistomum lysteri*
- Cestoda
    - *Diphyllobothrium dalliae**
    - *Diphyllobothrium* sp.*
    - *Proteocephalus* sp.
    - *Triaenophorus* sp.*
- Nematoda
    - *Anisakis* sp.*
    - *Raphidascaris* sp.*
- Acanthocephala
    - *Neoechinorhynchus rutili*

ESOCIDAE, pikes

Esox lucius Linnaeus, northern pike

Trematoda
- *Crepidostomum farionis*

Cestoda
- *Cyathocephalus truncatus*
- *Triaenophorus crassus*

Nematoda
- *Raphidascaris* sp.*

Acanthocephala
- *Neoechinorhynchus tenellus*

MYCTOPHIDAE, lanternfishes

Stenobrachius leucopsarus (Eigenmann and Eigenmann), northern lampfish

Nematoda
- *Contracaecum* sp.*

CATOSTOMIDAE, suckers

Catostomus commersoni (Lacepède), white sucker

Cestoda
- *Glaridacris catostomi*

BATRACHOIDIDAE, toadfishes

Porichthys notatus Girard, plain midshipman

Trematoda
- *Opechona alaskensis*

GADIDAE, codfish

Boreogadus saida (Lepechin), Arctic cod

Trematoda
- *Hemiurus levinseni*

Nematoda
- *Contracaecum* sp.*
- *Hysterothylacium aduncum**

Acanthocephala
- *Corynosoma* sp.
- *Echinorhynchus gadi*
- *Metechinorhynchus salmonis*

Gadidae (continued)

- _Eleginus gracilis_ (Tilesius), saffron cod
  - Cestoda
    - _Diphyllobothrium phocarum_*
- _Gadus macrocephalus_ Tilesius, Pacific cod
  - Nematoda
    - _Anisakis_ sp.*
    - _Phocanema decipiens_*
  - Hirudinea
    - _Levinsenia rectangulata_
  - Isopoda
    - _Rocinela belliceps_
  - Copepoda
    - _Clavella adunca_
    - _C. irina_
    - _Lepeophtheirus cuneifer_
    - _Lepeophtheirus parviventris_
    - _Naobranchia occidentalis_
- _Lota lota_ (Linnaeus), burbot
  - Acanthocephala
    - _Neoechinorhynchus rutili_
- _Merluccius productus_ (Ayres), Pacific hake
  - Trematoda
    - _Aponurus argentini_
    - _Aporocotyle margolisi_
    - _Derogenes macrostoma_
    - _D. varicus_
    - _Fellodistomum furcigerum_
    - _Lecithochirium_ sp.
  - Cestoda
    - _Bothriocephalus ospariichthydis_
    - _Bothriocephalus_ sp.*
    - _Diphyllobothrium_ sp.*
    - _Nybelinia surmenicola_*
    - _Scolex_ sp.*
  - Nematoda
    - _Anisakis_ sp.*
    - _Contracaecum_ sp.*
    - _Hysterothylacium aduncum_
    - _H. melanogrammi_
  - Copepoda
    - _Acanthochondria_ sp.
    - _Haemobaphes_ sp.
    - _Parabrachiella_ sp.

Gadidae (continued)

Microgadus proximus (Girard), Pacific tomcod

Copepoda
    Lepeophtheirus cuneifer
    Clavella canaliculata
Hirudinea
    Levinsenia rectangulata

Theragra chalcogramma (Pallas), walleye pollock

Cestoda
    Nybelinia sp.*
Nematoda
    Anisakis sp.*
Copepoda
    Clavella adunca
    Clavella perfida
    Lepeophtheirus cuneifer

ZOARCIDAE, eelpouts

Lycodes palearis Gilbert, wattled eelpout

Trematoda
    Derogenes varicus

Lycodes turneri Bean, polar eelpout

Copepoda
    Diocus frigidus

MACROURIDAE, grenadiers

Coryphaenoides cinereus

Myxozoa
    Ceratomyxa asymmetrica
    Myxoproteus abyssus

Coryphaenoides longifilis

Myxozoa
    Myxoproteus abyssus
    Zschokkella meglitschi

Coryphaenoides pectoralis (Gilbert), giant rattail

Monogenea
    Cyclocotyloides pinguis
Trematoda
    Gonocerca oshoro

GASTEROSTEIDAE, sticklebacks

Gasterosteus aculeatus Linnaeus, threespine stickleback

Trematoda
- *Bunodera* sp.
- *Peracreadium gasterostei*

Cestoda
- *Schistocephalus solidus**

Nematoda
- *Contracaecum* sp.*

Acanthocephala
- *Acanthocephalus lucii*
- *Neoechinorhynchus rutili*

Copepoda
- *Ergasilus auritus*
- *Ergasilus turgidus*
- *Thersitina gasterostei*

Mollusca
- *Anodonta beringiana*
- *Anodonta oregonensis*

Pungitius pungitius (Linnaeus), ninespine stickleback

Cestoda
- *Diphyllobothrium* sp.*
- *Schistocephalus solidus**

BRAMIDAE, pomfrets

Brama japonica Hilgendorf, Pacific pomfret

Trematoda
- *Lampritrema miescheri*

BATHYMASTERIDAE, ronquils

Ronquilus jordani (Gilbert), northern ronquil

Trematoda
- *Derogenes varicus*

STICHAEIDAE, pricklebacks

Lumpenus sagitta Wilimovsky, snake prickleback

Copepoda
- *Lepeophtheirus cuneifer*

SCORPAENIDAE, scorpionfish

Sebastes aleutianus (Jordan and Evermann), rougheye rockfish

- Monogenea
  - _Benedenia derzhavini_
  - _Trochopus_ sp.
- Trematoda
  - _Derogenes varicus_
  - _Neolepidapedon sebastisci_
  - _Podocotyle_ sp.
  - _Prosorhynchus crucibulum_
  - _Stephanostomum dentatum_
- Cestoda
  - _Nybelinia surmenicola_*
  - _Phyllobothrium_ sp.*
- Nematoda
  - _Contracaecum_ sp.*
  - _Cucullanus_ sp.
  - _Hysterothylacium aduncum_
- Acanthocephala
  - _Corynosoma_ sp.*
  - _Echinorhynchus gadi_
- Copepoda
  - _Brachiella robusta_
  - _Chondracanthus pinguis_
  - _Clavella parva_
  - _Colobomatus kyphosus_
  - _Sarcotaces arcticus_

Sebastes alutus (Gilbert), Pacific ocean perch

- Monogenea
  - _Benedenia derzhavini_
  - _Microcotyle sebastis_
  - _Trochopus_ sp.
- Trematoda
  - _Derogenes varicus_
  - _Fellodistomum sebastodis_
  - _Lecithaster gibbosus_
  - _Lecithophyllum botryophorum_
  - _L. spaerolecithum_
  - _Neohelicometra sebastis_
  - _Opechona alaskensis_
  - _Podocotyle atomon_
  - _Podocotyle_ sp.
  - _Prosorhynchus crucibulum_
  - _Psettarium sebastodorum_
- Cestoda
  - _Bothriocephalus scorpii_
  - _Bothriocephalus scorpii_*
  - _Nybelinia surmenicola_*
  - _Phyllobothrium_ sp.*
  - _Scolex pleuronectis_*

Scorpaenidae (continued).

Nematoda
- *Ascarophis pacificus*
- *Contracaecum* sp.*
- *Cucullanus heterochrous*
- *Cucullanus* sp.
- *Hysterothylacium aduncum*

Acanthocephala
- *Bolbosoma caenoforme*
- *Corynosoma reductum*
- *Corynosoma* sp.
- *Corynosoma* sp.*
- *Echinorhynchus gadi*

Copepoda
- *Brachiella robusta*
- *Chondracanthus pinguis*
- *Chondracanthus triventricosus*
- *Clavella parva*
- *Colobomatus kyphosus*
- *Haemobaphes theragrae*
- *Sarcotaces arcticus*

Sebastes ciliatus (Tilesius), dusky rockfish

Monogenea
- *Trochopus* sp.

Trematoda
- *Derogenes varicus*
- *Fellodistomum sebastodis*
- *Lecithophyllum botryophorum*
- *Opechona alaskensis*
- *Opechona occidentalis*
- *Podocotyle* sp.
- *Prosorhynchus crucibulum*

Cestoda
- *Nybelinia surmenicola**
- *Phyllobothrium* sp.*

Nematoda
- *Contracaecum* sp.*
- *Hysterothylacium aduncum*

Acanthocephala
- *Corynosoma* sp.*

Copepoda
- *Brachiella robusta*
- *Chondracanthus pinguis*
- *Chondracanthus triventricosus*
- *Colobomatus kyphosus*

Sebastes flavidus (Ayres), yellowtail rockfish

Copepoda
- *Sarcotaces arcticus*

Scorpaenidae (continued)

Sebastes melanops Girard, black rockfish

- Monogenea
  - *Trochopus marginata*
- Copepoda
  - *Clavella parva*
  - *C. recta*

Sebastes polyspinis Taranetz and Moiseev, northern rockfish

- Trematoda
  - *Fellodistomum sebastodis*
  - *Opechona alaskensis*
  - *Podocotyle* sp.
  - *Psettarium sebastodorum*
- Cestoda
  - *Nybelinia surmenicola**
  - *Phyllobothrium* sp.*
- Nematoda
  - *Contracaecum* sp.*
  - *Hysterothylacium aduncum*
- Copepoda
  - *Chondracanthus pinguis*
  - *Chondracanthus triventricosus*
  - *Colobomatus kyphosus*

Sebastes reflexa

- Trematoda
  - *Podocotyle reflexa*

Sebastes ruberrimus (Cramer), yelloweye rockfish

- Monogenea
  - *Trochopus marginata*

Sebastes zacentrus (Gilbert), sharpchin rockfish

- Monogenea
  - *Benedenia derzhavini*
  - *Microcotyle sebastis*
  - *Trochopus* sp.
- Trematoda
  - *Derogenes varicus*
  - *Neolepidapedon sebastisci*
  - *Opechona alaskensis*
  - *Podocotyle* sp.
  - *Prosorhynchus crucibulum*
  - *Psettarium sebastodorum*

Scorpaenidae, _Sebastes zacentrus_ (continued)

- Cestoda
  - _Bothriocephalus scorpii_*
  - _Nybelinia surmenicola_*
  - _Phyllobothrium_ sp.*
- Nematoda
  - _Contracaecum_ sp.*
  - _Hysterothylacium aduncum_
- Acanthocephala
  - _Corynosoma_ sp.*
  - _Echinorhynchus gadi_
- Copepoda
  - _Brachiella robusta_
  - _Chondracanthus pinguis_
  - _Chondracanthus triventricosus_
  - _Colobomatus kyphosus_
  - _Haemobaphes theragrae_

ANOPLOPOMATIDAE, sablefish

Anoplopoma fimbria (Pallas), sablefish

- Trematoda
  - _Stephanostomum californicum_
- Cestoda
  - _Nybelinia surmenicola_*
  - _Scolex_ sp.*
- Nematoda
  - _Contracaecum_ sp.*
  - _Phocanema_ sp.*
- Acanthocephala
  - _Corynosoma_ sp.*

HEXAGRAMMIDAE, greenling

Hexagrammos lagocephalus (Pallas), rock greenling

- Trematoda
  - _Urinatrema aspinosum_
- Nematoda
  - _Phocanema decipiens_*
- Acanthocephala
  - _Corynosoma_ sp.
- Copepoda
  - _Lepeophtheirus cuneifer_

Pleurogrammus monopterygius (Pallas), Atka mackerel

- Copepoda
  - _Lepeoptheirus parviventris_

COTTIDAE, sculpins

Cottus aleuticus Gilbert, coastrange sculpin

Protozoa
- *Cryptobia* sp.

Hemilepidotus hemilepidotus (Tilesius), red Irish lord

Trematoda
- *Derogenes varicus*
- *Prosorhynchus* sp.*

Nematoda
- *Phocanema decipiens**

Acanthocephala
- *Corynosoma* sp.

Leptocottus armatus Girard, Pacific staghorn sculpin

Copepoda
- *Lepeophtheirus cuneifer*

Myoxocephalus polyacanthocephalus (Pallas), great sculpin

Copepoda
- *Chondracanthus lotellae*

Hirudinea
- *Levinsenia rectangulata*

CYCLOPTERIDAE, snailfish

Aptocyclus ventricosus (Pallas), smooth lumpsucker

Trematoda
- *Prosorhynchus mizelli*

PLEURONECTIDAE, righteye flounders

Atheresthes stomias (Jordan and Gilbert), arrowtooth flounder

Trematoda
- *Stephanostomum* sp.*

Cestoda
- *Nybelinia surmenicola**

Acanthocephala
- *Corynosoma strumosum*
- *Echinorhynchus* sp.

Nematoda
- *Phocanema* sp.*
- *Contracaeceum* sp.*

Pleuronectidae (continued)

Eopsetta jordani (Lockington), petrale sole

- Myxozoa
  - *Kudoa* sp.

Hippoglossus stenolepis Schmidt, Pacific halibut

- Myxozoa
  - *Kudoa* sp.
- Monogenea
  - *Entobdella hippoglossi*
- Trematoda
  - *Derogenes varicus*
  - *Pseudopecoelus nossamani*
- Isopoda
  - *Rocinela angustata*
  - *Rocinela belliceps*
- Copepoda
  - *Acanthochondria cornuta*
  - *Lepeophtheirus appendiculatus*
  - *Lepeophtheirus cuneifer*
  - *Lepeophtheirus parviventris*

Isopsetta isolepis (Lockington), butter sole

- Copepoda
  - *Lepeophtheirus cuneifer*

Lepidopsetta bilineata (Ayres), rock sole

- Trematoda
  - *Derogenes varicus*
- Copepoda
  - *Lepeophtheirus parviventris*

Microstomus pacificus (Lockington), Dover sole

- Myxozoa
  - *Kudoa* sp.

Platichthys stellatus (Pallas), starry flounder

- Copepoda
  - *Lepeophtheirus parviventris*

Pleuronectes quadrituberculatus Pallas, Alaska plaice

- Copepoda
  - *Lepeophtheirus marcepes*

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Sea Level Variations at Monterey, California

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January 1983

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Sea Level Variations at Monterey, California

DALE EMIL BRETSCHNEIDER and DOUGLAS R. McLAIN[1]

ABSTRACT

Sea level data from Monterey, Calif., during the period 1963 through 1976 were compared with data from coastal stations from Peru to Alaska. Sea level fluctuations at Monterey were correlated with data from these stations, particularly those to the south. The causes of sea level fluctuations at Monterey were investigated by correlation, regression, and spectral analysis of sea level with atmospheric pressure, zonal and meridional wind stress, Ekman and Sverdrup transport, surface temperature and salinity, and dynamic height data from nearby locations. Of these variables, dynamic height was the best predictor of sea level fluctuations. Atmospheric pressure, surface temperature, and meridional wind stress were of secondary importance. The prediction was better during the Davidson Current period than during the upwelling period.

INTRODUCTION

Sea level and its fluctuations have interested man for centuries. Historical sea level time-series data are unique among marine data sources in that they have been obtained continuously and inexpensively over periods of decades or longer at many coastal and island locations worldwide. Sea level records include not only periodic fluctuations due to astronomic tides but also nontidal, low frequency fluctuations resulting from various oceanic and atmospheric processes. The nontidal components can be isolated by filtering out the astronomic tides, thus making measurements of sea level useful as a spacially integrated index of nearshore and offshore ocean changes.

This paper examines the character of sea level anomalies at Monterey, Calif., and the relative importance of the large-scale atmospheric and ocean processes which may cause nontidal, low frequency fluctuations. An understanding of these processes will allow the use of the abundant historical records of sea level data to reconstruct changes in the past oceanographic environment of the California Current system, which, in turn, may aid in understanding past changes in distribution, abundance, and availability of marine fish populations. In particular, the study was designed to examine the utility of sea level data for identification of anomalous environmental periods and for monitoring of changes in coastal oceanographic conditions.

EARLIER STUDIES ON SEA LEVEL VARIATIONS

Sea level variations along the Pacific coast and their relationship to various environmental phenomena have been examined from a number of different points of view. In addition to the well-understood astronomically induced periodicities, it is widely recognized that coastal sea level measurements are influenced by: 1) wind waves and swell, 2) wind set-up or set-down against the coast due to storms, 3) changes in atmospheric pressure over the ocean surface, 4) redistribution of water mass due to wind stress, 5) changes in average density of the seawater column, 6) long period astronomic tides, 7) subsidence or uplift of the land upon which the tide gage is located, and 8) changes in total mass of water in the oceans associated with the glacial ice budget. These physical processes are discussed by Montgomery (1938). LaFond (1939) found close agreement between weekly mean sea level measured at La Jolla, Calif., and offshore geopotential topography, thus directly relating ocean currents to sea level. Jacobs (1939) suggested that the relationships observed by LaFond were not entirely due to changes in the density of surface water but rather to actual slopes induced by wind-driven water transport along the coast. Pattullo et al. (1955) found that south of lat. 40°N in the North Pacific Ocean, the seasonal variation of steric elevation and sea level are in phase, both having a maximum elevation in late summer or early fall and a minimum elevation in winter. This they took as a consequence of seasonal heating and cooling. These investigators further found that seasonal variations in sea level north of lat. 40°N along the northwest coast of the United States could not be explained by steric considerations alone, suggesting that nonisostatic processes such as wind and currents can lead to appreciable regional deviations. Roden (1960) used autocorrelation and spectral techniques to examine the relationship between monthly mean sea level pressure, wind, and sea surface temperature (SST) at several stations along the Pacific coast. He found good coherence between anomalies of sea level and atmospheric pressure, moderate to poor coherence between SST and sea level depending on the location of the station, and moderate coherence between anomalies of sea level and north-south component of the geostrophic wind. Sturges (1974) found high correlations between occasional steric observations and 3-d mean sea levels at Neah Bay, Wash., and San Diego, Calif. Reid and Mantyla (1976) demonstrated that the winter increase in seasonal sea level elevation along the northern North Pacific coast results from increased overall flow in the North Pacific subarctic cyclonic gyre.[2]

OCEAN AND ATMOSPHERIC PROCESSES NEAR MONTEREY

Monterey Bay is located along the central California coast, about 120 km south of San Francisco. The bay, which is bisected by a deep submarine canyon, is a large, semi-elliptical coastal feature measuring about 37 km wide at the mouth and about 19 km from the mouth to the innermost point.

The bay lies inshore of the broad, diffuse, southward flowing California Current. The strength of the Current is affected by the winds over the Current which, in turn, are controlled by the strength and location of the Aleutian low-pressure cell located over the Aleutian

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[2] After this paper was completed, the thesis of Chelton (1980) became available. The reader is referred to it for additional information on processes affecting sea level along the coast.

Islands, the Pacific high-pressure cell located east of the Hawaiian Islands, and the thermal low-pressure cell located in summer over the western United States. During spring and summer the Aleutian low normally weakens and the Pacific high intensifies and moves northward. Winds over the Current during this period are mainly from the northwest and are strongest when the Pacific high and thermal low-pressure cells are closest together and relatively intense. Winds weaken or change direction as this pressure gradient decreases. The seasonal change in strength and location of these pressure cells thus causes seasonal changes in the winds (Reid et al. 1958).

Skogsberg (1936) described three distinct phases or periods in the seasonal hydrography of Monterey Bay. The calendar year opens in the countercurrent or Davidson Current phase. In late fall and early winter of most years, winds are weak and variable and intermittent southerly winds occur. A northward flowing countercurrent is present at the surface close inshore off central California. The general north-northwest to south-southeast trend of the coastline and Ekman transport of surface water to the right of the wind cause onshore transport of surface waters and piling up against the coast. Minimal solar radiation and strong vertical mixing of surface waters by winter storms decrease SST's to a seasonal minimum during January or February. While SST's decline during the Davidson Current period, temperatures at deeper levels slowly increase due to advection of warm waters from the south. For example, temperatures at 50 m depth reach a seasonal maximum during December and January (Skogsberg 1936; Bolin and Abbott 1963). The end of the Davidson Current period is variable and difficult to pinpoint. About March, the offshore high pressure cell intensifies and northwest winds become frequent. The resulting Ekman transport causes offshore transport of surface water and, in the nearshore region, some of this water is replaced by cold, nutrient-rich subsurface water upwelled from the upper hundred or so meters. Upwelling is strongest when northerly winds are strongest, and near Monterey usually reaches a maximum in May or June (Bakun 1975). By August, northerly winds begin to slacken and the strong solar radiation of late spring and summer results in a steady rise in SST that usually continues through September. A period of calmer winds that Skogsberg (1936) called the oceanic period occurs in September and October. With a slackening of wind stress, the cool, upwelled water begins to sink and is replaced by warmer surface water from offshore. Coastal SST's rise to their highest seasonal values and strong vertical temperature gradients form (Bolin and Abbott 1963).

Thus the oceanographic regime off Monterey is marked by three distinct periods: the Davidson Current period, occurring during November through February, has weak northerly winds, strong winter storm events, northward current flow, and onshore transport of surface water. The upwelling period, occurring in March through August, has strong northwest winds, southward current flow, offshore transport of surface water, and upwelling of cool, nutrient-rich water. The oceanic period, occurring during September and October, is a period of calm between the northerly winds of the upwelling period and the southerly winds of winter. During this period, highest surface temperatures and strongest vertical temperature gradients occur. Although these are the average seasonal characteristics in the meteorological and oceanic regimes affecting Monterey Bay, there are marked year-to-year differences in both timing and intensity of the events.

DESCRIPTION OF DATA

Recorded tide data from the tide station at Monterey, Calif. were chosen for analysis because the tide gage lies along the biologically productive upwelling region off central California and is exposed to open ocean conditions with no nearby river discharge that may affect sea level measurements (such as at San Francisco or Crescent City, Calif.). The Monterey gage is the only primary tide station maintained by the National Ocean Survey (NOS) between San Francisco and Avila, and thus fills a large data gap along the central California coast. The Monterey station has been operated continuously since 1963 by the Naval Postgraduate School (NPS) but the time-series data have not been fully analyzed. The tide station is located along the southern edge of the bay near the end of Monterey Municipal Wharf No. 2 where the water has a depth of approximately 6.8 m. Because of the open shape of the bay and the narrow width of the continental shelf, tide measurements obtained here are presumed to approximate those of the open coast.

In addition to sea level data, meteorological and oceanographic data representative of the Monterey area, including surface atmospheric pressure data, geostrophic wind data, surface salinity and temperature data, and deep hydrocast data were used in this study. The geographic proximity of the various data sources allowed direct comparison of variables with minimal problems resulting from spatial distortion. Figure 1 shows the location from which each of the data sources was derived, along with bathymetric contours.

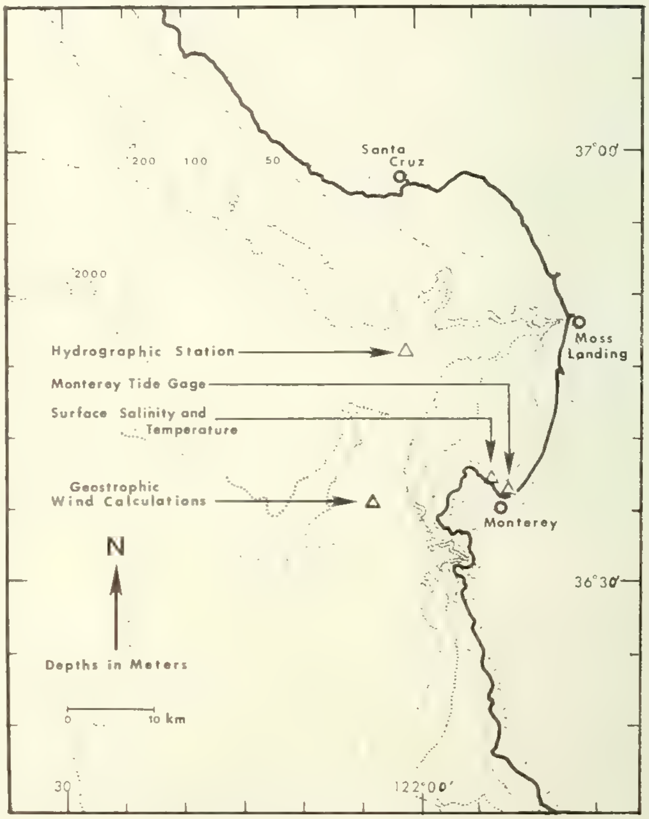

Figure 1.—Map of Monterey Bay, Calif., region showing location of data sources.

Monterey Sea Level Data

Tide Gages.—A standard recording tide gage, which traces tide heights continuously on a strip chart, was installed at the Monterey tide station by NPS personnel in June 1963. This analog system is entirely mechanical and is highly dependable when maintained properly. A drum-mounted strip chart is rotated by a spring-driven clock mechanism, and a pencil records sea level changes by means of a float-pulley system. A second instrument, a Fisher-Porter digital tide gage, was installed adjacent to the analog gage by the NOS in November 1973. This is an electrically operated system which punches digital data on foil tape. Both gages use the same 21.6 cm diameter float and have operated simultaneously since November 1973. The stilling well, which serves as a low pass filter for oscillations with periods greater than a minute, consists of a 30.5 cm diameter steel pipe with a 2.5 cm diameter orifice at the bottom. Both gages are checked for accuracy of time and height and are annotated about five times per week.

Data Processing and Reduction.—Continuous tide traces obtained from the analog gage during the period 20 July 1963 through 31 December 1974 were manually digitized for use in this study by Ocean Data Systems, Inc., Monterey, Calif. Datums were reviewed and data were reduced to hourly sea level heights using standard NOS procedures (Coast and Geodetic Survey 1965). Data from the digital gage for the period 1 January 1974 through 31 September 1976 were processed for hourly heights by the NOS and provided for use in this study. Data from both gages were recorded in feet and in this study converted to centimeters. The hourly heights from both analog and digital gages are accurate to about 0.1 ft (3.0 cm) and times of observation (Pacific Standard Time) are accurate to within 6 min. A small percentage of the hourly sea level data was missing, either rejected as erroneous or lost due to equipment malfunctions. As a result, some monthly means contain less than a full month of data. Missing data of duration of a day or longer are listed in Appendix A.

All hourly heights were measured relative to the station datum established by the NOS in November 1973. Mean sea level for the period 1963 through 1978 lies at 184.4 cm and the National Geodetic Vertical Datum lies 182.88 cm above the station datum.

Merging of Analog and Digital Tide Data.—To obtain the longest possible continuous tide record, it was necessary to merge the older analog data with the more recent digital data. Before the data sets were combined, the response of the two gauges was analyzed by comparing the hourly heights from both tide records for the calendar year 1974. The correlation coefficient between the analog and digital data sets exceeds 0.99, as anticipated.

The differences (digital-analog) between the two sets of hourly sea levels for the calendar year 1974 had a mean value of -0.06 cm. The frequency distribution of the differences (Fig. 2) resembles a normal distribution, with a standard deviation of 3.7 cm. Nearly all of the differences can be attributed to the fact that the digital data were recorded as instantaneous values, which can include short-term sea level fluctuations such as long period waves and seiches, whereas in the analog data, these short-term fluctuations were filtered out by manually smoothing the tidal curve before digitizing.

It was concluded that differences between the two data sets were negligible, and that the analog and digital data could be combined without significant error. Thus, analog data from the period 20 July 1963 through 31 December 1974 were combined with digital data from the period 1 January 1975 through 31 August 1976 to form a 13-yr time series containing 107,954 hourly observations.

Long Period Sea Level Changes.—Tide gages monitor the height of the sea level relative to land. Thus, changes in mean sea level over periods of years or decades can result from the addition or removal of water from the oceans due to global climatic variations, from subsidence or emergence of the land upon which the gage is located, or from long-period astronomic tides. For example, some long-period trends in sea level records, such as the rise in sea level in Panama described by Roden (1963) or the drop in sea level in the Juneau, Alaska, area described by Hicks (1973), clearly result from local or regional land subsidence or uplift.

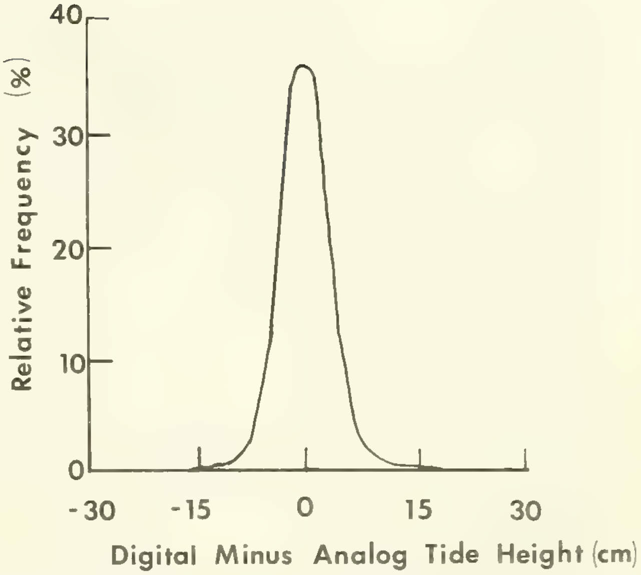

Figure 2.—Comparison of hourly tide measurements in Monterey Bay, Calif., from digital and analog gages for calendar year 1974. Total number of observations was 107,954.

To determine trends in the Monterey sea level record during the period 1963 through 1978, a least-squares linear fit was made to the time-series on monthly mean values. The fit showed a relative rise in sea level of about 0.01 cm/yr. The variability in sea level due to oceanographic and meteorological processes greatly exceeds this trend and thus the effects of long term trends were neglected in this study.

Of the long-period astronomic tides, the nodal tidal constituent, which results from the changing declination of the moon over a period of 18.61 yr, has the greatest amplitude. The theoretical amplitude of this constituent varies with latitude, with maximum effects at the Equator and the poles and minimum effects near lat. 35°N and 35°S (Lisitzin 1974). A second significant long period constituent, the annual solar tide, has an amplitude approximately one-fifth of the nodal tide component. The effects of this tidal constituent vary with latitude in a manner similar to that of the nodal tide. Monterey, located near lat. 36°N, is in a region where the ranges of both of these long period tides are about 1 cm, so these effects were neglected in this study.

Ocean and Atmospheric Data

The atmospheric pressure and wind data used in this study were derived from 6-h synoptic surface pressure fields prepared by Fleet Numerical Oceanography Center (FNOC). The pressure fields, interpolated onto a grid with a mesh length of 3° latitude and longitude, were used to compute geostrophic winds, from which wind stress, Ekman transport, and Sverdrup transport estimates were calculated at a deep water site approximately 14 km west of Monterey (Fig. 1). A description of the methods and computations used in these calculations is given by Bakun (1975). Briefly, the geostrophic wind was computed for the point lat. 36.6°N, long. 122.1°W and an estimate of the wind near the sea surface was made by rotating the geostrophic wind vector 15° to the left and reducing its magnitude by

30%. The surface wind stress was computed and the wind stress vector was resolved into north-south (meridional or alongcoast) and east-west (zonal or crosscoast) components. Ekman transport was computed and offshore-onshore transport was determined by resolving the vector component perpendicular to the general trend of the coastline. Sverdrup transport was calculated as described by Nelson (1977).

The surface temperature and salinity data were obtained from samples taken daily at Hopkins Marine Station of Stanford University during the period January 1963 to May 1975. SST data from June 1975 to December 1978 were taken at the Monterey tide station by NPS personnel. Salinity data from Hopkins Marine Station are not available later than May 1975.

To examine the relationship between sea level and dynamic height, a series of hydrographic cast data were assembled for a station located in mid-Monterey Bay, about 19 km northwest of the tide station (Fig. 1). This hydrographic station is located near the mouth of the Monterey submarine canyon where the water depth is over 900 m. The hydrographic cast data were taken semimonthly by the Hopkins Marine Station during 1963-73. Sampling during the first years of the program was limited to the upper 50 m of the water column but in 1968 the sampling depth was increased to over 500 m.[3] Sampling was discontinued by Hopkins in December 1973 and was resumed by Moss Landing Marine Laboratory from July 1974 to June 1978.[4]

The Hopkins and Moss Landing hydrographic data were keypunched and profiles of temperature and salinity and temperature-salinity curves were plotted for each station. Using these plots, obvious errors in the data were eliminated.

The time series of hydrographic stations had a gap in early 1974 between the end of Hopkins sampling and the beginning of Moss Landing sampling. Several expendable bathythermograph (XBT) drops taken during this period by NPS are available for the mid-bay location. To be able to utilize these XBT data, it was necessary to estimate a salinity value for each temperature value. A density value was calculated for each pair of temperature-salinity observations in the hydrographic cast data and correlation analysis was made. Density was found to be better correlated with temperature ($r = 0.98$) than was salinity with temperature ($r = 0.96$). Thus a density value was computed for each temperature in the XBT profiles and then a companion salinity value was calculated for each temperature and density pair. This procedure also allowed estimation of salinity for some of the hydrographic casts where temperature but not salinity values were recorded. The hydrographic data were then checked for density instabilities and finally, dynamic height was calculated for each profile for the 0/200, 0/400, and 200/400 db (decabars) levels. The depth of maximum calculation was limited by the XBT profiles which extended to only 460 m. The final time series contained 202 profiles to at least 400 m in the 10-yr period April 1968 to June 1978.

Monthly means and anomalies of sea level, and of the ocean and atmospheric data described in the above sections, are presented graphically and in tabular form in Appendix B.

SEA LEVEL AT MONTEREY

Although the time series of hourly sea levels contains much valuable information on the occurrence, amplitude, and duration of anomalous short period sea level fluctuations, it was decided for this study to concentrate on variations of sea level of monthly period and longer and on their atmospheric and oceanographic causes. Weekly and 6-h sea level data are discussed but in a more limited way as are the statistical characteristics of hourly deviations from the predicted sea level. Readers interested in short period fluctuations are referred to Maixner (1973) who examined Monterey sea level data during the year 1971.

Means and Variations

Hourly Sea Level.—To analyze nontidal sea level variations, which are small compared with the normal tide range in this area, the tidal signal must first be removed. Three methods for this are averaging, filtering, or subtracting predicted tides from the observed. The Tide Predictions Branch of the NOS performed a harmonic analysis of 365 d of hourly Monterey tide height values and isolated 37 harmonic constituents (Maixner 1973). Using the 20 constituents whose amplitudes were >0.61 cm, the NOS computed predicted hourly tide heights for the period of record, 1963 through 1976. Predicted hourly heights were then subtracted from the 13 yr of observed hourly heights to yield nonastronomic residuals. The frequency of occurrence of these sea level differences (observed minus predicted), which total nearly 108,000 values, approximates a normal or Gaussian distribution (Fig. 3). Of the observations, 94.5% lie within 15.2 cm (0.5 ft) of the predicted tide and 99.9% lie within 30.5 cm (1.0 ft). The maximum observed difference was 39.6 cm. The standard deviation of the differences was 8.7 cm, skewness -0.02, and kurtosis 3.2.

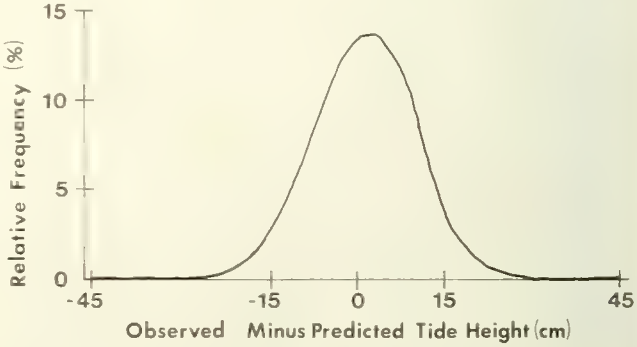

Figure 3—Frequency of occurrence of differences between observed and predicted hourly tide heights at Monterey, Calif., 1963-76.

The distribution of hourly differences describes nontidal sea level variations over a 13-yr period but gives no information about seasonal variations of the frequency distribution. Are distributions for winter months the same as those for summer? To define the seasonal change, curves were generated using data from 8,200 to 9,800 observations for each of the 12 mo of the year (Fig. 4). The frequency distribution of nontidal sea level fluctuations changes seasonally. In April, for example, 73% of the observed sea levels were lower than predicted, but in September, 81% of the observed data were greater than predicted. From March through May, observed sea levels tend to be lower than predicted sea levels, probably due to offshore Ekman transport, low water temperature, and atmospheric pressure effects as discussed later. From July through January, observed sea levels are higher than predicted due to atmospheric pressure and thermal expansion effects during summer and fall, and to onshore transport, pressure, and thermal effects during the Davidson Current period in December and January. It is not clear why these seasonal differences occur since one would expect seasonal effects to have been included in the harmonic constituents. Perhaps the differences occur because of variations in the frequency of occurrence of events in different years. Thus harmonics generated from measurements in only a single year may not be typical of other years.

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[3] Hopkins Marine Station. CalCOFI Hydrographic Data, collected on approximately bi-weekly cruises on Monterey Bay, California. Annual reports for years 1968 to 1973 (mineogr.). Hopkins Marine Station, Pacific Grove, CA 93950.

[4] Broenkow, W. W., S. R. Lasley, and G. C. Schrader. 1975. CalCOFI Hydrogrphic Data Report, Monterey Bay, July to December 1974. Tech. Publ. 75-1. Moss Landing Mar. Lab., Moss Landing, CA 95039.

Broenkow, W. W., S. R. Lasley, and G. C. Schrader. 1976. CalCOFI Hydrographic Data Report, Monterey Bay, January to December 1975. Tech. Publ. 76-1 Moss Landing Mar. Lab., Moss Landing, CA 95039.

Lasley, S. R. 1976. CalCOFI Hydrographic Data Report, Monterey Bay, January to December 1976. Tech. Publ. 77-1. Moss Landing Mar. Lab., Moss Landing, CA 95039.

Chinburg, S. J., and S. R. Lasley. 1977. CalCOFI Hydrographic Data Report, Monterey Bay, January to December 1977. Tech. Publ. 78-1. Moss Landing Mar. Lab., Moss Landing, CA 95039.

Chinburg, S. J. 1979. CalCOFI Hydrographic Data Report, Monterey Bay, January to June 1978. Tech. Publ. 79-1. Moss Landing Mar. Lab., Moss Landing, CA 95039.

The distributions of differences for winter months are wider and less peaked than those of summer months, indicating greater variability and larger nontidal events such as winter storms. In contrast, the distributions for July and August are narrow and more peaked.

Monthly Mean Sea Level.—Averaging of hourly sea level values over intervals of weeks to months removes the effects of the principal diurnal, semi-diurnal, and other short-term tidal components from the data to reduce the quantities of data to manageable size and to emphasize the longer time scales.

Monthly means of the hourly values were calculated for the period July 1963 through August 1976 and were updated for the period September 1976 through December 1978 with monthly mean values provided by the NOS. Figure 7 shows the long-term monthly means, standard deviations, and extremes of the monthly means of sea level at Monterey and other stations along the coast. Mean sea level at Monterey is lowest in April and highest in September, with a mean annual range of 13.6 cm. Variability is highest during winter months, with monthly standard deviations during winter being almost double those for summer. The range between maximum and minimum monthly values reaches a high of 21.0 cm in January and a low of 8.5 cm in August.

Anomalies of monthly sea level were calculated as differences between the monthly mean and the long-term mean for the same month. Calculation of anomalies in this manner removes the annual cycle from the data and allows examination of processes of nonannual periods. Monthly mean sea levels and their anomalies are shown in tabular and graphical form in Appendix B. In these figures extreme monthly sea level anomalies are shown to range from -10.8 cm in December 1975 to +10.7 cm in January 1978. Periods of anomalously high sea level occurred during 1969, 1972-73, 1976-77, and early 1978, and periods of anomalously low sea level occurred in 1964, 1970, 1971, 1973, 1975-76, and 1977.

To statistically define the persistence of anomalous periods, the autocorrelation function was used. This function describes the decay of the correlation coefficient of the data series with itself as the date series is time shifted relative to itself an increasing number of lag periods (months). The autocorrelation function of monthly Monterey sea level anomalies (Fig. 5) shows that sea level anomalies are correlated at the 5% level of significance for lags of up to 5 mo, indicating that anomalies persist over a period of several months. The autocorrelation function of the sea level series appears to decay exponentially for the first 8 mo or so, with significant negative autocorrelation coefficients occurring from lags of 11 to 18 and 23 to 26 mo.

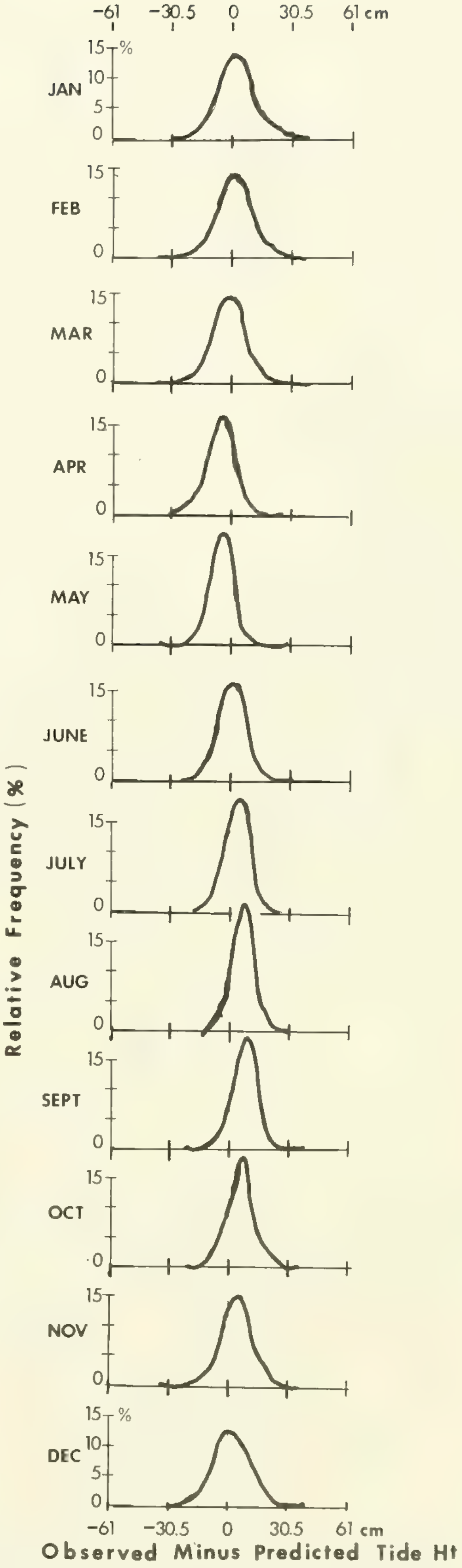


Figure 4.—Frequency of occurrence by month of differences between observed and predicted hourly tide heights at Monterey, Calif., 1963-76.

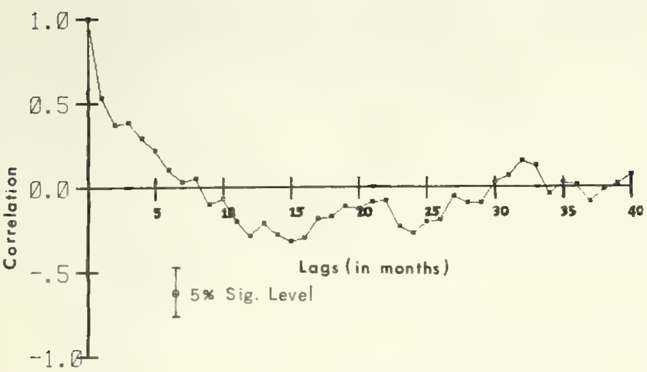


Figure 5.—Autocorrelation function for anomaly of monthly mean sea level at Monterey, Calif. The number of data points is 180 and the significance level is computed assuming a normal distribution of correlation coefficients.

Relation to Other Pacific Coast Tide Stations

We have seen that mean monthly sea level anomalies at Monterey tend to persist for up to 5 mo. The question naturally arises as to whether these anomalies are of local or regional geographic extent. To determine the spacial and temporal coherence between the monthly anomalies at Monterey and those observed at neighboring tide recording stations, monthly mean data were assembled for 15 tide stations along the Pacific coast ranging from Sitka, Alaska, to Callao, Peru (Fig. 6). These data were obtained from Klaus Wyrtki of the University of Hawaii and from the NOS. Stations selected for analysis were those having the best combination of the following characteristics: 1) representativeness of open ocean conditions, 2) long and continuous data record, 3) a constant tidal reference datum, and 4) suitable spacing between station locations along the coast. For each station, long-term monthly means were calculated from the available data for the period 1963 to 1978 and monthly sea level anomalies were derived (Fig. 7).

For stations north of Crescent City, frequent energetic winter storms cause the time series of anomalies to have only moderate persistence whereas stations south of San Francisco have much greater persistence of anomalies. Perhaps the most striking feature of the time series is the high visual correlation of anomalies along the coast (Bretschneider and McLain 1979; Enfield and Allen 1980). The periods of anomalously high sea level at Monterey during 1969, 1972-73, 1976-77, and 1978 were common to most stations where data are available. Similarly, the periods of anomalously low sea level seen at Monterey in 1964, 1970, 1971, 1973, 1975-76, and 1977 occurred at most of the other stations.

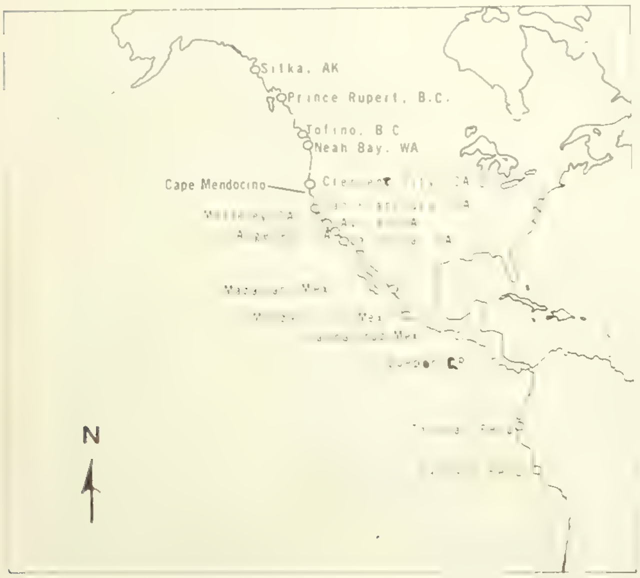


Figure 6.—Location of 15 tide stations along the west coasts of North and South America whose data were used in this study (see text).

Correlations of the monthly sea level anomalies between stations were calculated using the BMDP8D statistical program (Dixon 1975) and are tabulated in Table 1. The correlation of the selected tide stations relative to Monterey is shown graphically in Figure 8. Correlation of the Monterey anomalies is seen to be highest with San Francisco ($r = 0.85$) and lowest with Sitka ($r = 0.15$). Note also that the correlation coefficient drops off more rapidly with distance to the north of Monterey than to the south, due to the different space scales of the processes affecting sea level to the north and south.

Osmer and Huyer (1978) suggested the existence of two domains of coastal sea level fluctuations, with a boundary located south of San Francisco in winter and north of Crescent City in the spring and summer. The general location of their break-point is in agreement with the findings of Zee (1975), who suggested that sea level anomalies at stations from San Francisco southward to the Equator were related to nonseasonal vertical movements of the thermocline. That an oceanographic gradient or boundary may exist between northern and southern stations is further suggested by Nelson (1977) who showed that the area off northern California near Cape Mendocino is one of marked change in the seasonal surface wind stress field. The mean seasonal wind stress field over the coastal ocean south of Cape Mendocino is alongshore (southward) all year while the stress field north of Cape Mendocino is strongly onshore in winter and alongshore (southward) in summer.

The geographic coherence of sea level anomalies observed at Monterey with the neighboring tide stations along the coast was further examined in a time-distance domain. The monthly anomalies from the series of 15 coastal stations from Sitka, Alaska, to Callao, Peru, were plotted and contoured at 5 cm intervals for the period 1963 to 1974 (Fig. 9). Data for the years 1975-78 were not available for several of the stations so plots for these years are not included. The monthly anomalies have recognizable patterns which are coherent in both time and space. For example, large negative anomalies can be seen in January 1963 extending from Crescent City to Sitka and large positive anomalies in the same region occur in the subsequent fall and winter.

Anomalies of greater magnitude and stronger gradients in time and space occur northward of a boundary zone lying between Crescent City and Monterey, than to the south. Anomalous events north of this zone tend to occur simultaneously along the coast and persist for 1 or 2 mo. Anomaly magnitudes and gradients are also generally larger southward of a second, less well-defined boundary zone lying approximately between Manzanillo and Quepos. Between these boundary zones, gradients of the anomaly field are relatively weak. Southward of the zone between Crescent City and Monterey, sea level anomalies are of relatively long duration, as was noted earlier.

A particularly interesting event is the anomalously high sea level during the period October 1972 through February 1973 between Callao and San Francisco. This was a period of strong El Niño activity in the eastern tropical Pacific. During El Niño occurrences warm advection occurs into the eastern tropical Pacific Ocean and high SST's are observed. Sea level rapidly rises in the eastern tropical Pacific and falls slowly in the western Pacific (Wyrtki 1977). A peak sea level anomaly

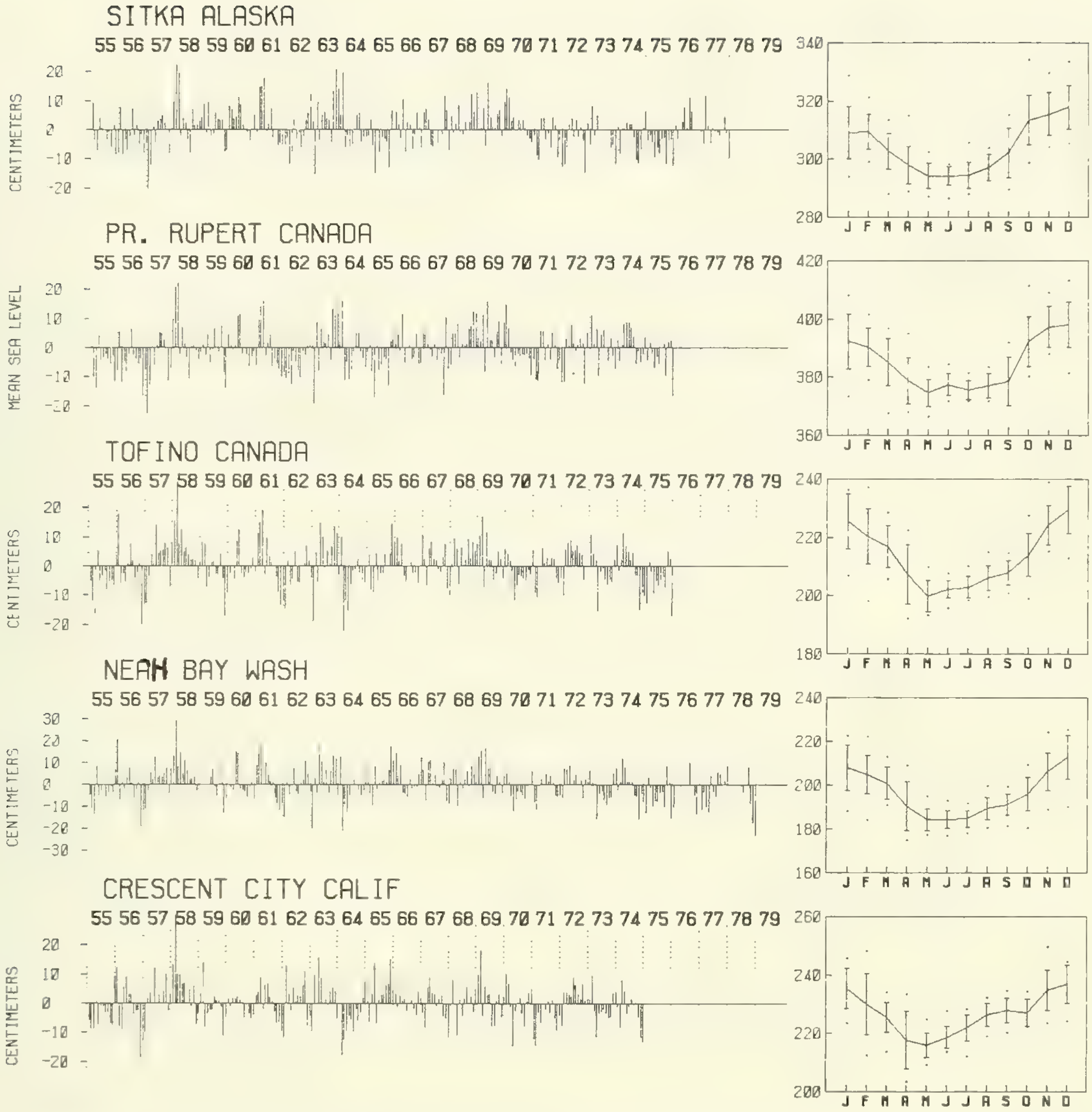


Figure 7.—Time series of monthly sea level anomalies for selected west coast tide stations. Inserts show mean annual cycle with standard deviations as vertical bars and monthly extremes as dots.

of 25 cm occurred at Manzanillo in December 1972, where the occurrence of high sea levels preceeded those observed at more northern stations by a month or more. At Monterey, sea levels were higher than average during the winter of 1972-73 (see also Fig. 7). During the El Niño period (see time-series plots in Appendix B), atmospheric pressures at Monterey were less than average and wind stress was negligible except during February 1973 when anomalous southerly winds resulted in onshore transport of surface waters and downwelling.

The strong alongcoast correlation of monthly sea level anomalies shows that sea level changes at Monterey are related to large-scale influences rather than to strictly local events. Table 1 shows that the anomalies at Monterey are correlated, at the 5% level of significance, with anomalies recorded at stations from Prince Rupert, Canada, to Callao, Peru, but are more closely related to events affecting sea levels in the group of stations from Crescent City to Quepos, Costa Rica. Processes producing the El Niño phenomenon in the eastern tropical Pacific also apparently affect sea level at Monterey. Recent theories (e.g., McCreary 1976) predict a deepening of the thermocline associated with the El Niño, which propagates northward along the coast as a Kelvin wave, and that northward geostrophic currents are produced behind the Kelvin wave fronts. Such currents cause changes in the cross shelf sea surface slope and northward advection of warm water. Both processes would cause anomalous increases in sea level at stations along the coast.

CAUSES OF SEA LEVEL VARIATIONS AT MONTEREY

The effects on sea level of changes in atmospheric pressure, changes in sea surface slopes due to changes in alongcoast currents, and changes in average density of the water column are all interrelated. A change in the distribution of atmospheric pressure over the ocean surface will generally change the horizontal gradient of pressure, resulting in a change in the geostrophic and other wind compo-

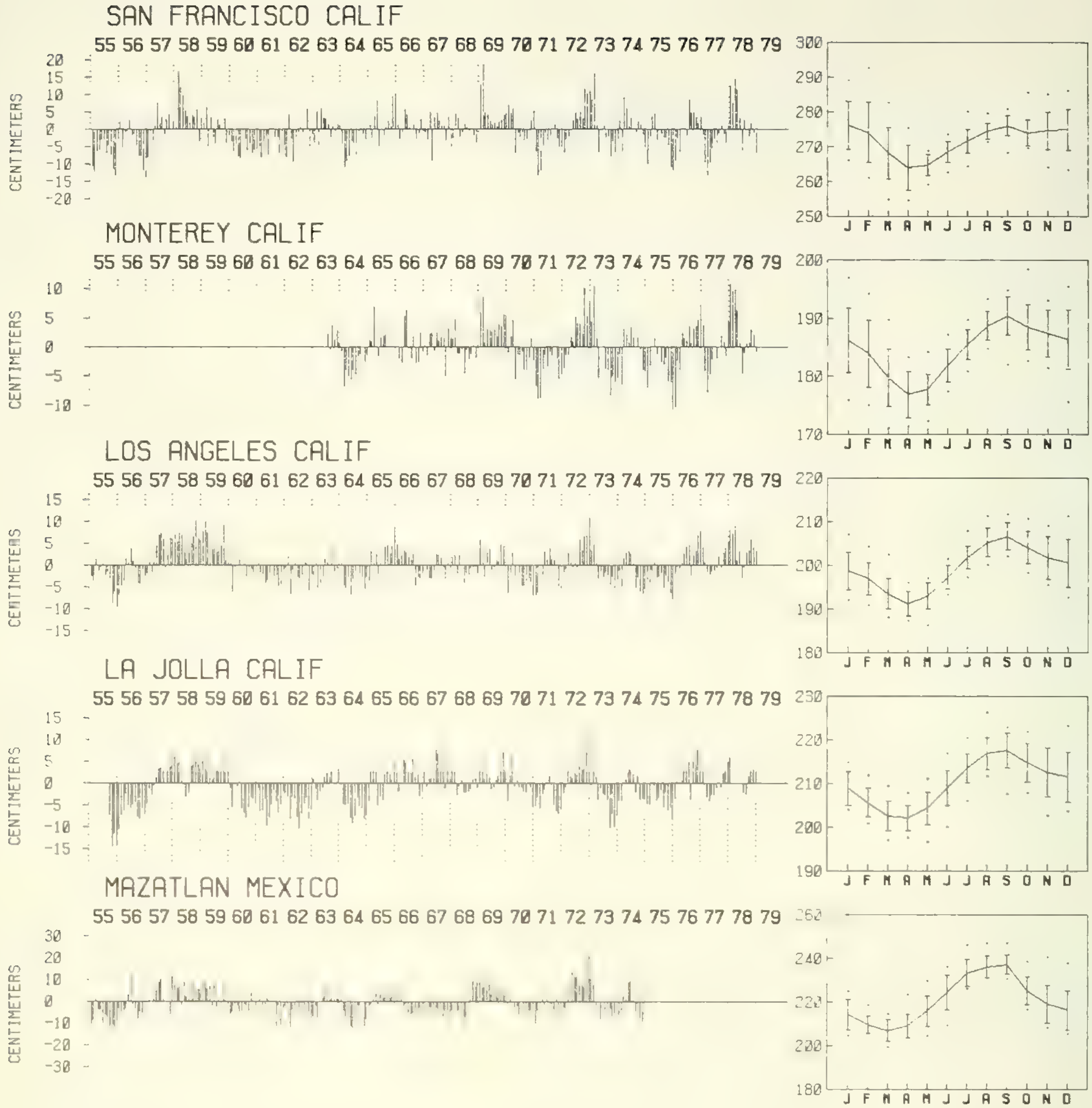


Figure 7.—*Continued.*

nents, and thus in wind stress. A change in wind stress will change the wind-driven current, redistribute the mass, and change the average density of the water column. Wind stress changes also alter wind-induced set-up or set-down against the coast. All of these processes combine with effects of a northward propagating wave from the tropics to affect sea level at Monterey.

Records of SST and salinity changes reflect changes in oceanographic conditions at the sea surface and may also be indicative of changes in the subsurface density distribution. Dynamic height calculations, however, provide a direct measure of the subsurface density field and its changes, and therefore reflect large scale changes in ocean circulation. If a strong relationship between sea level and dynamic height were found, it would allow use of inexpensive tide gage data to monitor changes in coastal circulation. The time series of frequent hydrographic stations taken in mid-Monterey Bay during 1968 to 1978 provide a unique opportunity to test for such a relation.

Correlation, regression, and spectral analysis techniques were used to study the causes of the sea level variations. These variations occur on various time scales and the analysis techniques used were chosen as appropriate for the time scale and character of the data to be analyzed. Thus, this section is organized generally by time-sampling and specifically by analysis procedures.

Correlation Analysis

Long term monthly means and anomalies for the period 1963-78 were calculated for the following oceanic and atmospheric variables: surface atmospheric pressure, meridional component of wind stress, zonal wind stress, offshore component of Ekman transport, Sverdrup transport, salinity, SST, and 0/400 db dynamic height. The data are presented numerically and graphically in Appendix B. Correlations between these variables and the monthly sea level anomalies at Monterey were calculated using the BMDP8D statistical program (Dixon 1975) and the results are given in Table 2. The correlation analysis measures the strength of the linear relationship between two random variables. However, the variables dealt with here are not random and may be mutually dependent on some third but unmeasured variable. Thus care must be used in interpretation of the statistical results. In

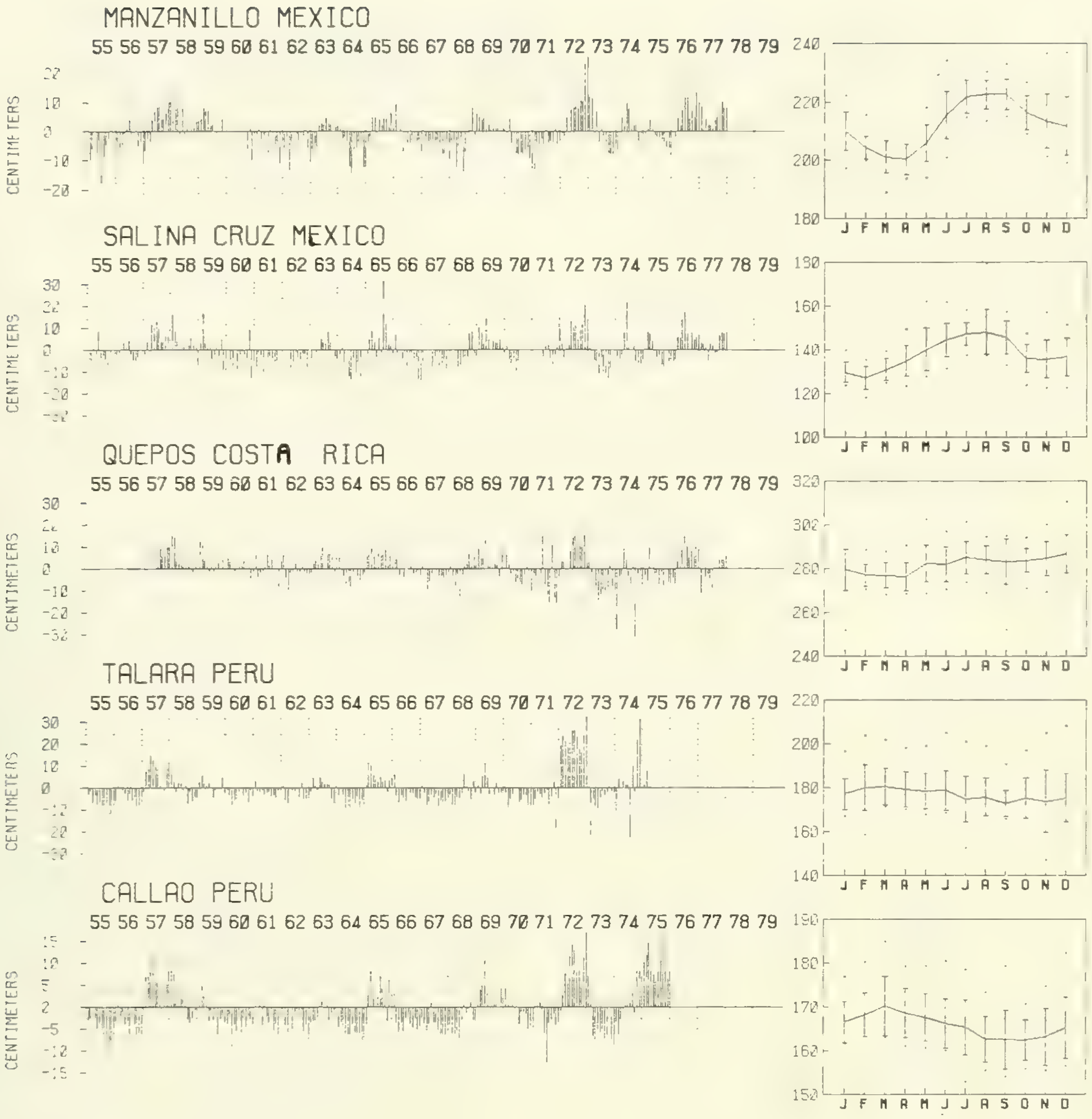


Figure 7.—*Continued.*

the following paragraphs each variable will be treated in turn and the results of the correlation analysis will be discussed.

The effect on sea level of changes in atmospheric pressure over the oceans has been examined by a number of authors (Patullo et al. 1955; Saur 1962; Roden 1960). An increase (decrease) in atmospheric pressure results in a decrease (increase) in sea level. The pressure effect can be quite large in some areas, particularly in the Gulf of Alaska where winter storms are intense or along the Gulf or Atlantic coasts of the United States during the passage of hurricanes.

The isostatic contribution of atmospheric pressure variations to variations in sea level is computed from the hydrostatic equation $\Delta p = -\rho g \Delta h$ where Δp is the change in atmospheric pressure in millibars (mb), ρ is the density of water in g/cm^3, g is the acceleration of gravity in cm/s^2, and Δh is the change in sea level in centimeters. Applying this equation to seawater of density 1.025 g/cm^3 and using 980.7 cm/s^2 as the acceleration of gravity, we find that an increase in atmospheric pressure of 1 mb will result in a 0.995 cm depression of sea level.

The annual seasonal range of monthly mean atmospheric pressure at Monterey during the period 1963-78 was 7.3 mb, but pressure changes several times greater than this are not uncommon during the passage of intense winter storms. Thus, the effect of atmospheric pressure is expected to account for a significant portion of sea level variability near Monterey.

Maixner (1973) examined hourly data recorded from the Monterey tide gage during the year 1971 and concluded that sea level responds rapidly (within several hours) to pressure changes in an approximately hydrostatic manner. The coefficient of correlation between monthly mean sea level anomalies and pressure anomalies, based on 180 mo of simultaneous data from the period July 1963 through December 1978, was found in the present study to be -0.69 (Table 2). The relatively large negative correlation indicates a significant response of sea level to pressure.

It is desirable to remove the static effects of atmospheric pressure from the monthly sea level data so that the influence on sea level of other variables can be readily examined. To accomplish this, monthly

Table 1.—Intercorrelation of monthly mean sea level anomalies for selected west coast tide stations. Abbreviations refer to names of stations shown in Figure 6. Correlation coefficients enclosed in parentheses are not significant at the 5% level.

	CAL	TAL	QPO	SCZ	MAN	MZN	LJLA	LA	MTRY	SF	CC	NEA	TF	PR	SKA
CAL	1.00														
TAL	.71	1.00													
QPO	.49	.57	1.00												
SCZ	.50	.44	.55	1.00											
MAN	.54	.49	.56	.72	1.00										
MZN	.64	.43	.55	.68	.90	1.00									
LJLA	.22	.26	.43	.42	.56	.51	1.00								
LA	.19	.27	.50	.48	.63	.63	.79	1.00							
MTRY	.23	.21	.43	.43	.53	.56	.75	.75	1.00						
SF	.25	.17	.36	.31	.41	.49	.57	.58	.84	1.00					
CC	.24	(.13)	.31	.33	.33	.37	.35	.38	.62	.67	1.00				
NEA	(.00)	(.05)	.26	.23	.21	.36	.15	.21	.32	.43	.75	1.00			
TF	(.02)	(.04)	.24	.26	.32	.41	.27	.36	.40	.47	.76	.94	1.00		
PR	(.03)	(.00)	.16	(.08)	.28	.37	.16	.24	.21	.27	.34	.67	.73	1.00	
SKA	(-.10)	(-.10)	.21	(.01)	(.12)	.22	.17	.15	(.15)	.17	.20	.49	.55	.81	1.00

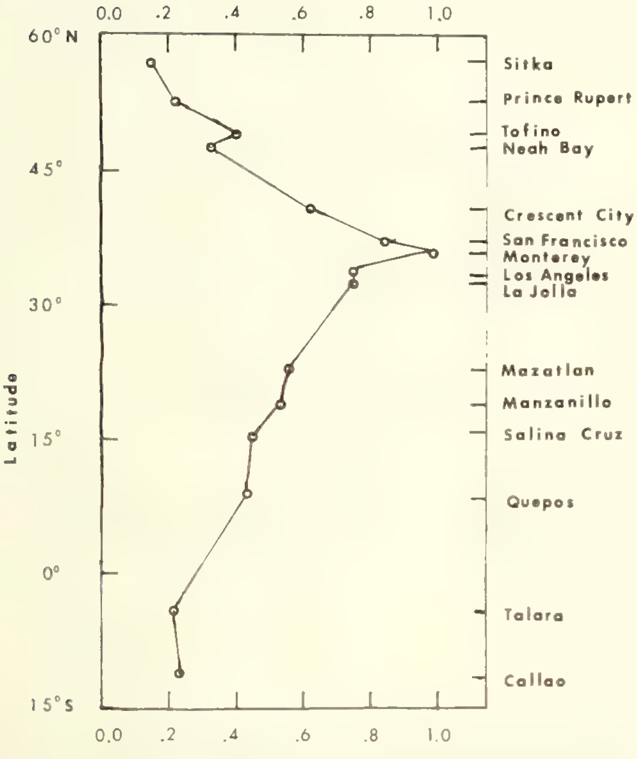


Figure 8.—Correlation of monthly sea level anomalies at selected west coast tide stations relative to Monterey, Calif.

mean sea levels were adjusted for monthly pressure effects by increasing (decreasing) sea level 1.00 cm for every 1.00 mb increase (decrease) of atmospheric pressure. The use of the more accurate value of 0.995 cm/mb was not warranted in this study. The magnitude of the pressure correction was determined by subtracting the long term mean pressure for the period January 1963 through December 1978 (1,016.85 mb) from the monthly mean atmospheric pressures. This method removes the effects of seasonal and interannual pressure changes. Mean monthly sea levels and sea level anomalies from which the hydrostatic effect associated with monthly pressure anomalies have been removed are referred to in this paper as adjusted sea levels.

In general, the effect of atmospheric pressure on sea level is small compared with the observed departures of sea level. In most months the pressure correction is opposite in sign to the sea level anomaly and reduces the variability of the sea level data. The effect of the static pressure correction on the seasonal sea level is to reduce the range of the monthly values, and to a lesser extent the seasonal range, but also to shift the month of occurrence of highest sea level from September to December. Pressure effects account for a portion of the sea level variability but significant nonbarometric residuals remain, indicating the effects of dynamic as well as static processes.

The effects of wind stress on sea level are two fold 1) the direct elevation or depression of water by winds normal to the coast and 2) the sea surface slopes created by offshore or onshore Ekman transport produced by winds parallel to the coast. The direct piling up of water against the shore is commonly observed along coasts with wide, shallow continental shelves or long, narrow embayments. The magnitude of this effect is dependent on basin configuration, surface wind velocity, depth of water, and the time scales considered. The continental shelf in the Monterey area is quite narrow with deep water located close inshore so that the effects of wind set-up are small. Defant (1961) showed, for example, that a constant 10 m/s wind blowing over a basin 50 m deep would produce a sea surface slope of 6.6 cm/100 km. The 50 m contour near Monterey is <1.6 km offshore (Fig. 1), and the magnitude of direct piling of water by the wind is thus less than the range of error in tide measurements. In addition, monthly anomalies of zonal (east/west) wind stress were found not to be significantly correlated with monthly sea level anomalies at the 5% level of significance (Table 2). Accordingly, elevation or depression of sea level by cross shore wind stress is neglected in this analysis.

The second effect of wind stress is that of sea surface slopes produced by offshore or onshore Ekman transport due to winds parallel to the coast. According to conventional Ekman transport theory, net transport is directed 90° to the right of the wind in the Northern Hemisphere. In this study, offshore/onshore Ekman transport was found to be significantly correlated with sea level ($r = -0.42$ in Table 2). The inverse correlation indicates that offshore transport results in decreased sea level and onshore transport in increased sea level. Meridional wind stress is also significantly correlated with sea level ($r = 0.43$), as expected. Monthly anomalies of Sverdrup transport were found not to be significantly correlated with monthly sea level anomalies at the 5% level.

Sea surface temperature and surface salinity are both significantly correlated with monthly sea level anomalies (with correlation coefficients of 0.61 and -0.35). The signs of the correlations indicate that

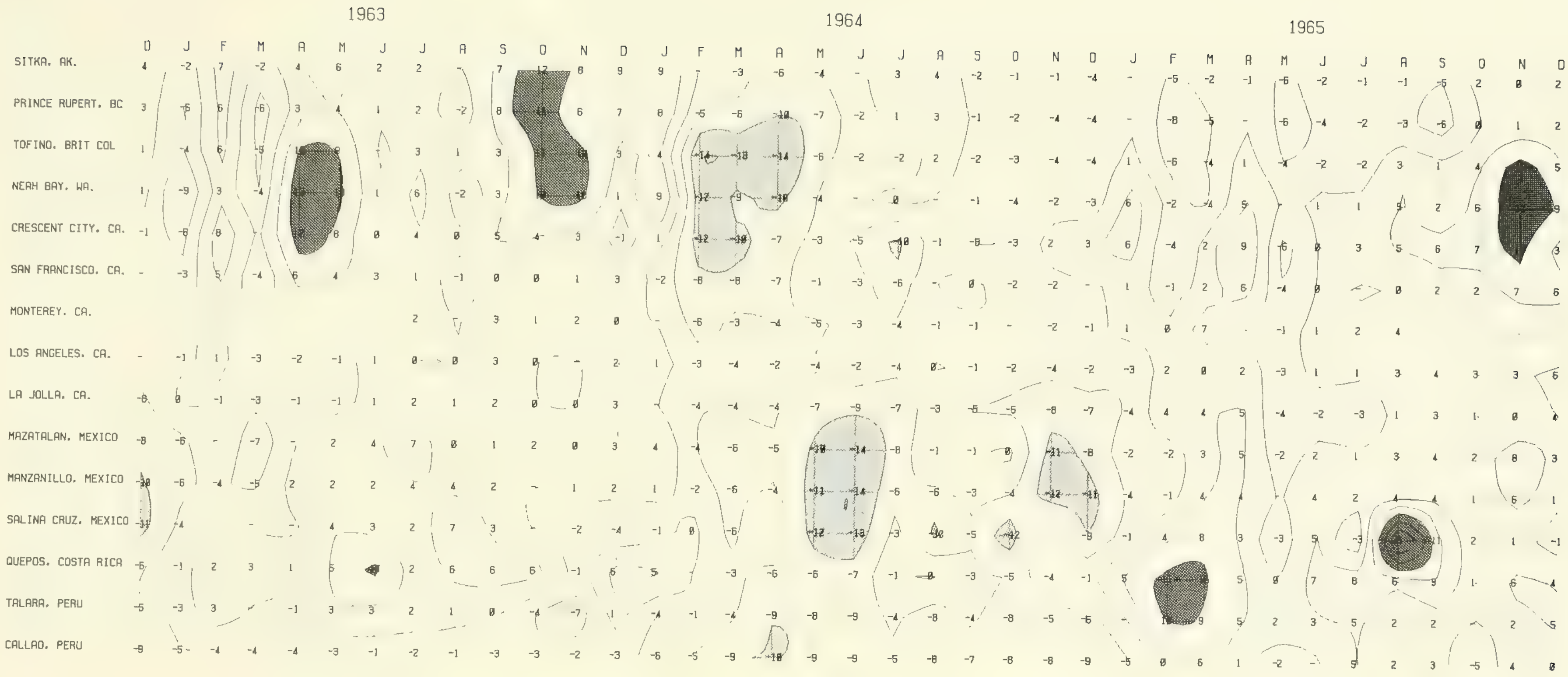
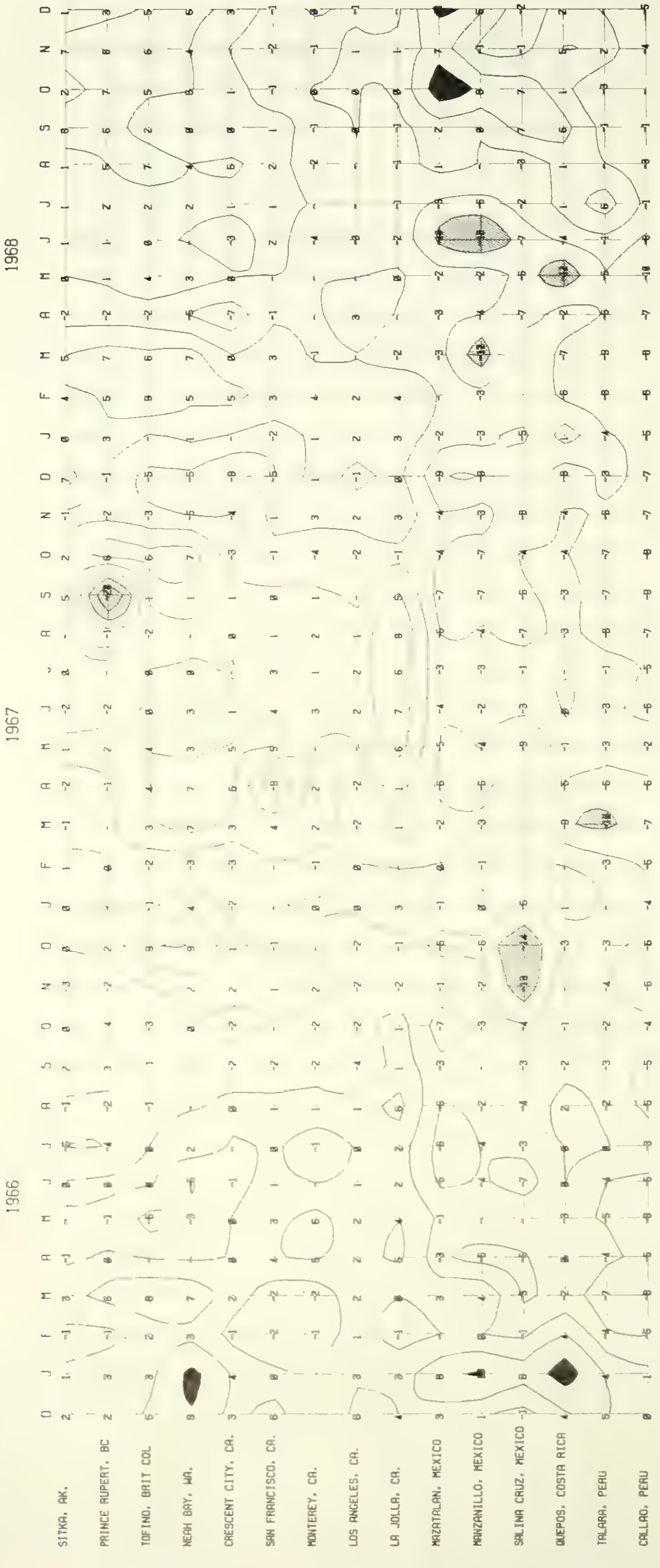


Figure 9.—Time-distance contour plot of monthly mean anomalies of sea level in centimeters from 1962-74 mean at selected west cost tide stations. The contour interval is 5 cm with areas greater than +10 cm shaded dark and areas less than -10 cm shaded light.



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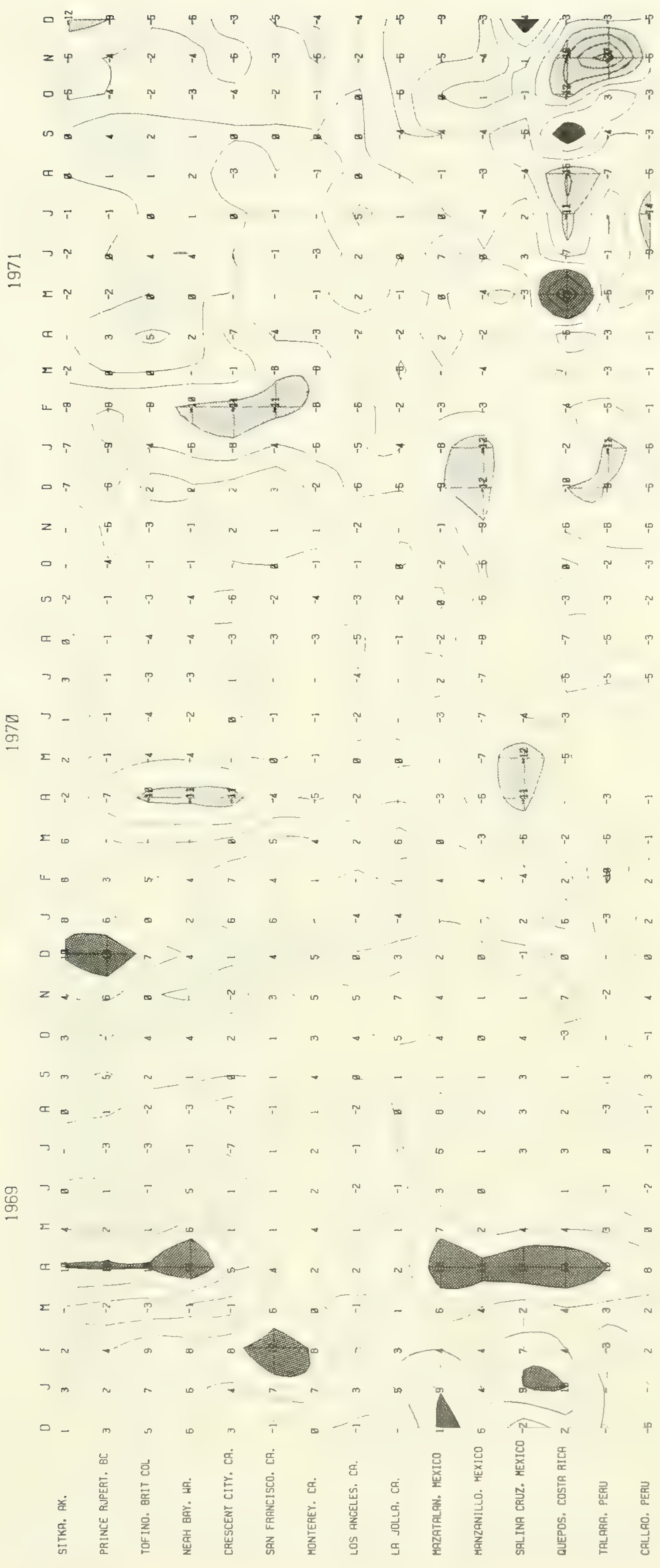

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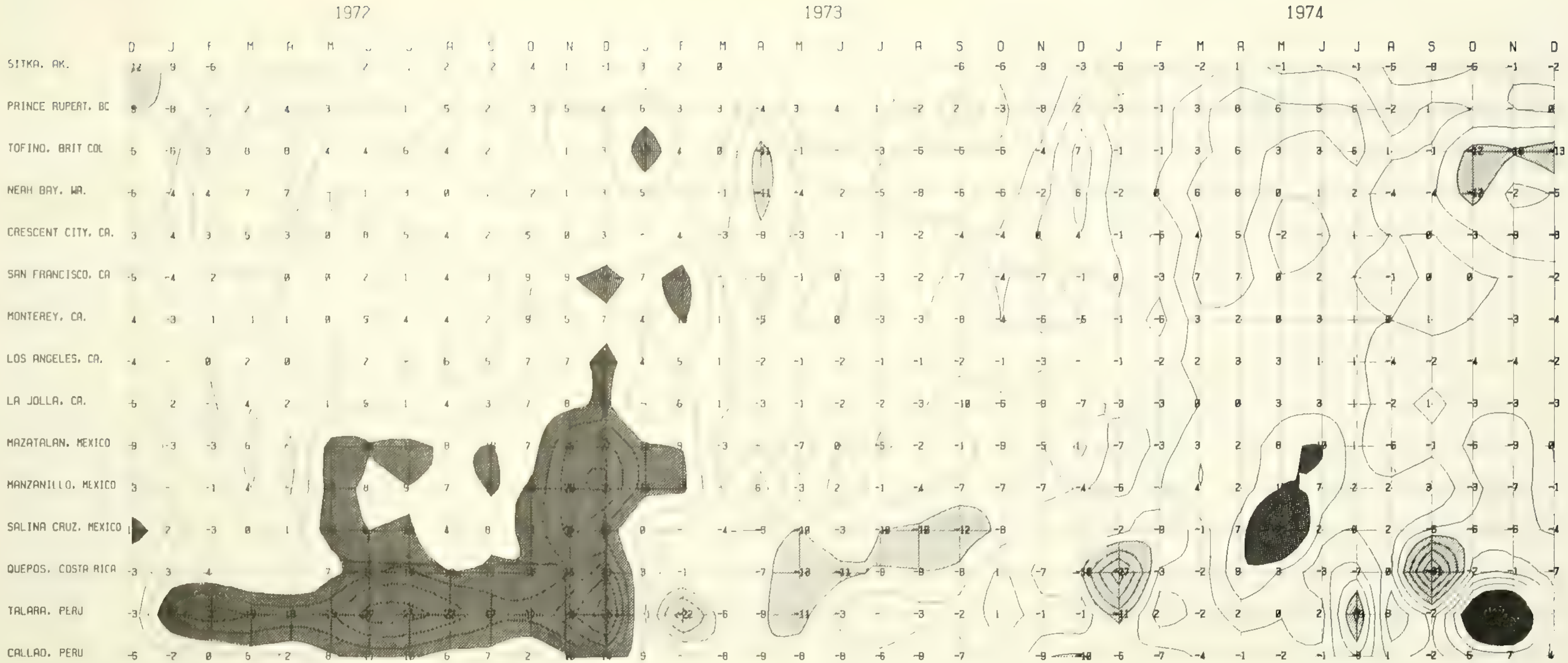

Figure 9.—*Continued.*

Table 2.—Intercorrelation of monthly mean anomalies of sea level with various oceanic and atmospheric variables at Monterey, Calif. (see text). Correlation coefficients enclosed in parentheses are not significant at 5% level.

	SL	ADJ SL	PRESS	MERID WS	ZONAL WS	EKM TSPT	SVP TSPT	SAL	SST	DYN HT
SL	1.00									
ADJ SL	.96	1.00								
PRESS	-.70	-.46	1.00							
MERID WS	.43	.42	-.28	1.00						
ZONAL WS	(-.14)	-.18	(-.03)	-.48	1.00					
EKM TSPT	-.42	-.42	.26	-.99	.59	1.00				
SVP TSPT	(.01)	(.07)	-.18	-.33	.15	.32	1.00			
SAL	-.35	-.31	.29	-.31	(.07)	.30	.20	1.00		
SST	.61	.65	-.29	.38	-.17	-.37	(-.05)	-.37	1.00	
DYN HT	.79	.79	-.46	.25	(-.08)	-.25	(.00)	-.44	.65	1.00

increases in SST are associated with increased sea levels and increased salinities are associated with decreased sea levels. These relationships are consistent with basic considerations of seawater density changes.

Dynamic height (0/400 db) at the mid-Monterey hydrographic station was found to be strongly correlated with sea level fluctuations at Monterey. The correlation coefficient of 0/400 db dynamic height was 0.79 with Monterey sea level and was the highest of any of the variables tested. The higher correlation of sea level with dynamic height than with SST ($r = 0.61$) suggests that subsurface fluctuations are important in causing changes of both sea level and dynamic height at Monterey. A possible cause of such subsurface fluctuations is the northward propagating coastally trapped wave mentioned earlier. To examine this, sea level at Talara, Peru, was used as an index of El Niño conditions and was lagged 0 to 10 mo for correlation with sea level at Monterey. The correlation coefficient peaked at $r = 0.37$ at a lag of 6 mo. A wave propagating the approximately 6,300 km between Talara and Monterey in 6 mo would have a phase speed of about 34 km/d. This is somewhat lower than speeds reported by Enfield and Allen (1980) but not inconsistent with their results.

Table 3.—Results of multiple regression analysis of sea level at Monterey, Calif., with various oceanic and atmospheric variables for entire year, Davidson Current, and upwelling periods. Data series are sea level (SL) in centimeters, atmospheric pressure (PRESS) in millibars, sea surface temperature (SST) in °C, meridional wind stress (MWS) in dynes/cm², and dynamic height (DYN HT) in centimeters.

Step	Variable	Explained variance	Increase in explained variance
A. Entire year (Jan.-Dec., 77 mo of data)			
1	DYN HT	.62	.62
2	PRESS	.70	.08
3	SST	.74	.04
4	MWS	.76	.02
Sea level = -0.057 + 0.470 DYN HT - 0.894 PRESS + 1.208 SST + 4.491 MWS			
B. Davidson Current period (Oct.-Feb., 31 mo of data)			
1	DYN HT	.76	.76
2	MWS	.82	.06
Sea level = -0.0653 + 0.732 DYN HT + 15.402 MWS			
C. Upwelling period (Apr.-Aug., 33 mo of data)			
1	DYN HT	.36	.36
2	MWS	.52	.16
3	PRESS	.60	.08
4	SST	.66	.06
Sea level = -0.108 - 0.935 PRESS + 0.256 DYN HT + 4.256 MWS + 1.271 SST			

Regression Analysis

We have seen that the monthly anomalies of sea level at Monterey are significantly correlated with dynamic height, atmospheric pressure, SST, meridional wind stress, offshore Ekman transport, and surface salinity. To quantify these relationships, a multiple regression analysis was performed using the BMDP2R stepwise multiple regression program (Dixon 1975). Since fluctuations of meridional wind stress and offshore Ekman transport are closely related ($r = 0.99$ in Table 2), use of both variables in a regression would cause instabilities in the computation. Ekman transport was omitted from the regressions and only the meridional wind stress considered since the wind stress is the more fundamental variable.

The results of the regression analysis for the entire year, presented in Table 3 (Part A), show that dynamic height is the major predictor of sea level, with atmospheric pressure, SST, and meridional wind stress as second, third, and fourth predictors. The remaining variables explained only negligible portions of the variance and their coefficients are not included in the table. Together, the four major predictors explain over 76% of the variance of the monthly sea level anomalies with dynamic height alone explaining 62% of the variance. Considering that the sea level was recorded hourly in a consistent fashion while dynamic height was computed from observations taken at scattered times by several institutions using different methods, the strength of the relation seems very good.

The relationship between sea level and dynamic height was further examined in a seasonal sense. There is good agreement in both phase and amplitude of the long term monthly means of dynamic height and adjusted sea level (Fig. 10). The observed seasonal cycle for dynamic height is somewhat more variable than that of sea level, possibly as a result of limited sampling (there were only 12 or 13 stations per month during winter but up to 24 stations per month the rest of the year). The figure shows that both sea level and dynamic height near Monterey are highest in winter and lowest in spring.

Reid and Mantyla (1976), showed that south of lat. 40°N in the eastern North Pacific Ocean sea levels are typically highest in late summer and early fall and lowest in late winter as a result of annual solar heating. North of lat. 40°N, however, sea levels are highest in winter and lowest in summer; this pattern cannot be explained by the steric response to seasonal heating and cooling. Using Sturges' (1974) data from Neah Bay, Reid and Mantyla further demonstrated that maximum sea levels occur in winter when inshore northward flow is strongest and minimum sea levels occur during summer when flow is southward, thus relating seasonal changes in sea level to geostrophically balanced flow. Monterey lies at lat. 36°N and has a seasonal cycle that is intermediate between these regimes.

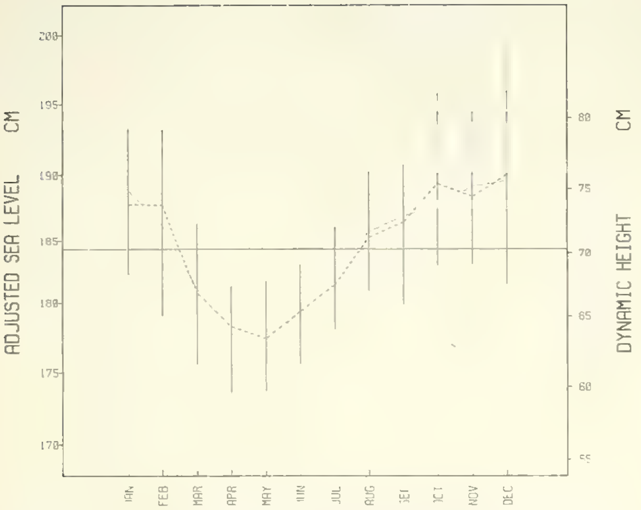

Figure 10.—Seasonal cycle of sea level and dynamic height near Monterey, Calif. Sea level data are for 1963-78 and shown as dotted line and dynamic height data are for 1968-77 and shown as dashed line. Ranges of monthly sea levels are shown by vertical bars.

Sea level and dynamic height are also in good agreement in a time series sense. Figure 11 shows the time series of weekly mean sea level, calculated from the hourly data, and individual dynamic height calculations relative to 200 and 400 db. The figure shows that both sea levels and dynamic heights were higher than normal during 1969–70, 1972–73, and 1976, which were periods of El Niño activity in the eastern tropical Pacific. Sea levels and dynamic heights were both also near or below normal during anti-El Niño periods. Because of the close agreement between seasonal cycles of sea level and dynamic height, and because of the high correlation of sea level at Monterey with that at adjacent stations, dynamic height and sea level variations may both reflect variations in the alongshore geostrophic current flow. To show this, one would have to show that fluctuations of sea level were correlated with fluctuations of slope of dynamic height normal to the coastline. Suitable data for this may be available but this was felt to be beyond the scope of this report.

The regression formula indicates that the response of sea level to changes in atmospheric pressure is -1.67 cm/mb whereas a purely hydrostatic response would be -1.00 cm/mb. This higher than theoretical pressure response coefficient is poorly understood but is possibly due to reinforcement of the local pressure effect by a larger scale, dynamic aspect of the atmospheric pressure systems themselves. Saur (1962) and Roden (1960) analyzed monthly tide data from stations to the north and south of Monterey and found similar larger than expected pressure response coefficients.

Because of the significant seasonal changes in the oceanic and atmospheric regimes near Monterey, we might expect to observe seasonal changes in the processes affecting sea level. To define these seasonal changes, the ocean and atmospheric variables were analyzed separately for the two major periods, the Davidson Current and the upwelling periods (Table 3).

Sea level changes during the Davidson Current period were analyzed using data from 5 mo, October through February, for the years 1963-78. The results of multiple regression analysis indicate that dynamic height and meridional wind stress are major predictors of sea level during this period, explaining 82% of the variance of monthly sea level anomalies. During this period, dynamic height and sea level are strongly correlated, $r = 0.87$.

The second period analyzed was centered during the upwelling period and covered 6 mo, April through August, during the years 1964-78. During this period, dynamic height remains the primary predictor but at weaker correlation, $r = 0.60$. Atmospheric pressure, SST, and meridional wind stress are secondary predictors and in total account for 66% of the variability of monthly sea level.

Thus, some seasonal change in the processes affecting sea level is indicated, with dynamic height accounting for most of the sea level variability in both the upwelling and Davidson Current periods. Meridional wind stress is also important during both periods but more so during the upwelling than Davidson Current period. Atmospheric pressure and SST explain an additional portion of the sea level variability during the upwelling period. The greater amount of explained variance in winter than summer suggests that conditions in winter are dominated by changes in the structure of the water column whereas upwelling in summer causes complicated effects on sea level.

Spectral Analysis

In the previous section, it was shown that most of the variance of monthly sea level anomalies can be explained by monthly anomalies of dynamic height, surface atmospheric pressure, SST, and meridional wind stress. However, important variations in these processes occur on time scales shorter than a month. To determine how the variance of sea level is distributed with frequency over time-periods of days to weeks, auto- and cross-spectra were calculated for 6-h observations of sea level, atmospheric pressure, and meridional wind stress. Spectra of dynamic height and SST were not computed because the required data were too sparse.

To prepare these data for spectral analysis, it was necessary to subsample the hourly sea level series at the 6-h period of the available surface atmospheric pressure and meridional wind stress data. Atmospheric pressure and meridional wind stress were calculated as described previously on a 6-h basis for the period 1 January 1967 through 31 August 1976 for a point approximately 14 km west of the Monterey tide station (Fig. 1). Hourly sea level data for the same time period were low-pass filtered to remove the diurnal, semidiurnal, and other short-term tidal components and were subsampled at 6-h intervals. A complete description of the low-pass filter used is given by Godin (1966). All data series were then detrended by subtracting their 30-d running mean to produce band-passed series. The response function for the 30-d running mean is shown in Figure 12.

Atmospheric pressure, wind stress, and sea level data (unadjusted for pressure effects) were analyzed during the winter storm season (1 November to 8 March) and the upwelling period (1 April to 8 August) for the years 1967-76. The definition of these periods is somewhat arbitrary but was based on visual interpretation of time series of sea level and wind stress and on the requirement that the number of data points used in the spectral analysis be a power of 2. Since the periods are normally 3-4 mo long, 512 data points (128 d) were used. A fast Fourier transform spectrum analysis with a triangular data window was used and the spectra were averaged for all available years. The frequency bandwidth is 0.04 cycles per day (cpd) and the number of degrees of freedom is 90 for the winter period and 100 for the upwelling period.

The spectral relationships between sea level and atmospheric pressure are discussed first. In the low frequency region, the winter period spectra (Fig. 13) are three to four times more energetic than the upwelling period spectra (Fig. 14), indicating the effects of intense winter storm events. The largest sea level and pressure fluctuations

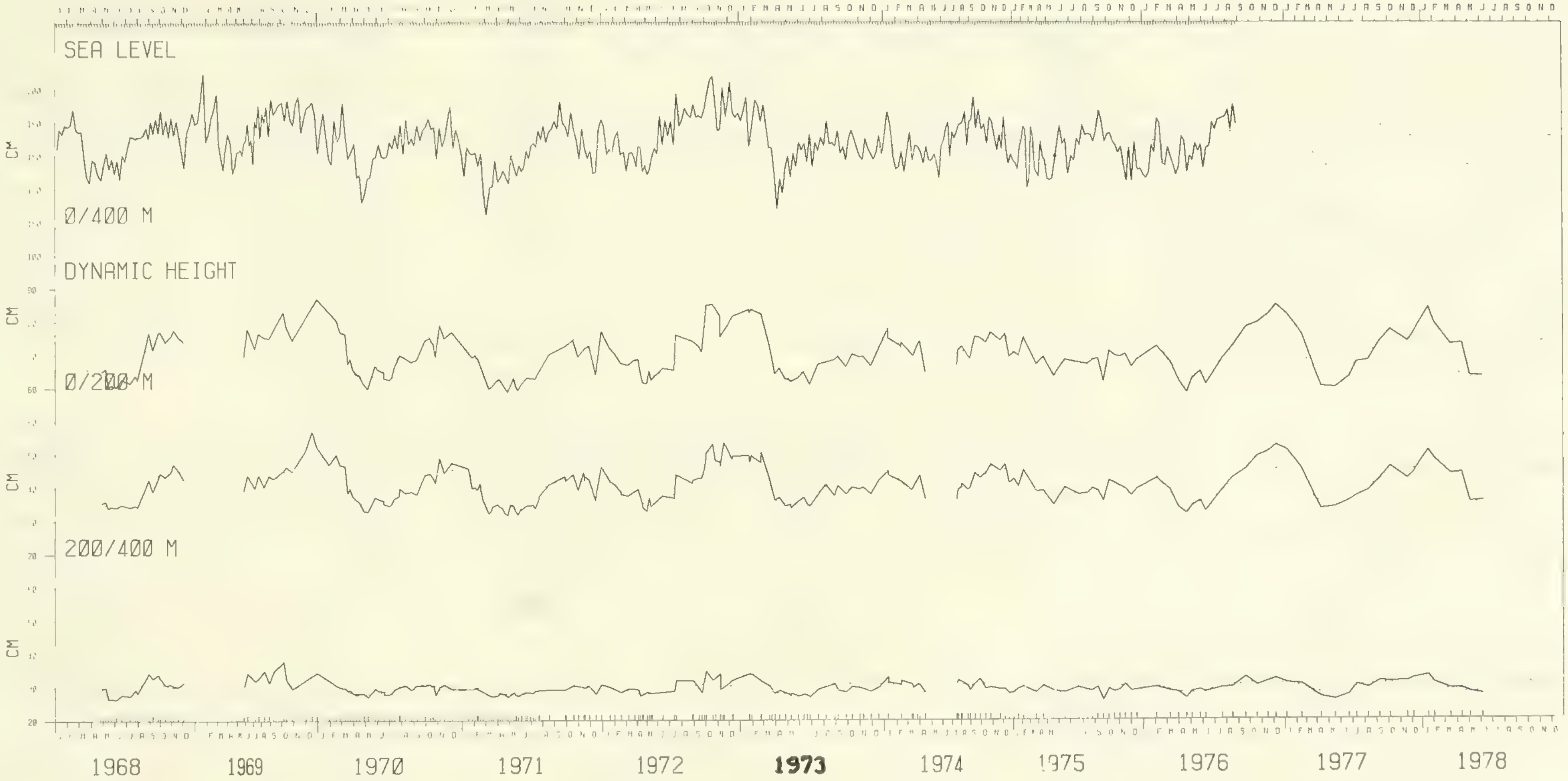

Figure 11.—Time series of weekly mean sea level at Monterey, Calif., and dynamic height computed from frequent hydrographic stations in mid-Monterey Bay. The mean annual cycles are shown as dotted lines.

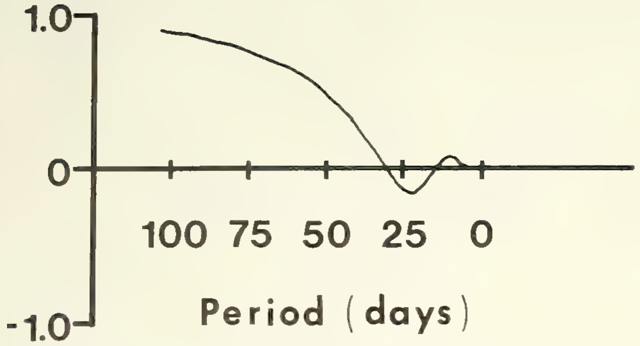

Figure 12.—Amplitude response function for the 30-d running mean filter used to low pass filter hourly sea level data from Monterey, Calif.

occurred in the 0.04-0.08 cpd frequency band (24-12 d). This peak was present in all series and was significant at the 95% confidence level for pressure but not for sea level. Fluctuations of longer period than this peak appear to be more important for sea level than for pressure. The filters used in the analysis had been designed to isolate variations with periods 2-10 d (0.5-0.2 cpd) but did not reveal any significant spectral peaks in that region.

The coherence (squared) between sea level and atmospheric pressure was found to be significant and independent of frequency in the upwelling period (Fig. 14), but in the winter period (Fig. 13), decreased in magnitude at frequencies greater than 0.5 cpd (<2d). The nearly constant 180° phase angle between the two series reflects the inverse response between atmospheric pressure and sea level as expected from the hydrostatic equation.

In order to better examine the relationship of wind stress and sea level, the low-passed 6-h sea level series was adjusted for atmospheric pressure effects and detrended using the 30-d running mean filter described previously. Auto- and cross-spectra were then calculated for the 6-h adjusted sea level and meridional wind stress series (Figs. 15, 16). Like the atmospheric pressure and unadjusted sea level series, meridional wind stress had a concentration of energy at low frequencies with large variations occurring in the 0.04-0.08 cpd frequency band, and the winter season power spectra contained more energy than that of the upwelling season. Coherence between adjusted sea level and meridional wind stress is generally low. The phase angles provide little information because of the low coherence.

SUMMARY

Analysis of 13 yr of hourly sea levels indicates that nontidal sea level variations are small compared with the normal tide range in the area. The largest nontidal deviation observed was 39.6 cm. A seasonal change revealed by monthly frequency distributions of hourly nontidal sea level variations was found, with observed sea levels being generally less than the predicted during March through May and greater than the predicted from July through January.

Monthly sea level anomalies at Monterey are correlated with anomalies at tide stations from Prince Rupert, Canada, to Callao, Peru, but are most closely related to events affecting sea levels in the group of stations from Crescent City, Calif., to Quepos, Costa Rica. Processes producing the El Niño phenomenon in the eastern tropical Pacific affect sea level at Monterey with a lag of about 6 mo.

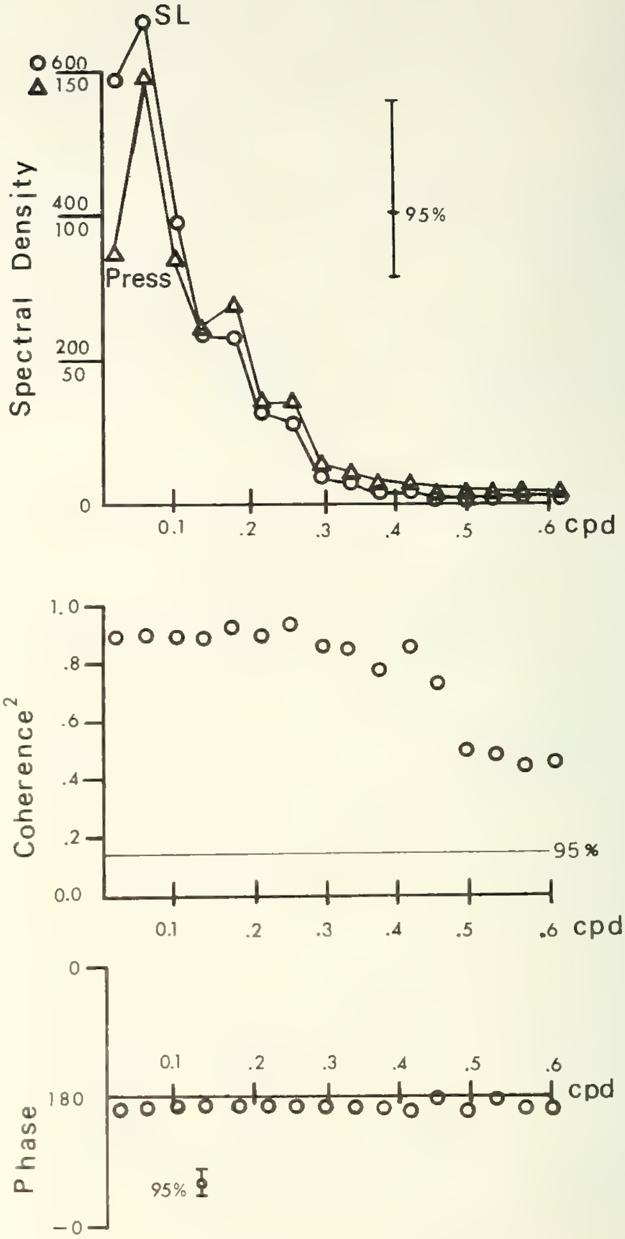

Figure 13.—Spectral plots of 6-h atmospheric pressure (Press) and unadjusted sea level (SL) for the winter period (df = 90) at Monterey, Calif. The horizontal axes are frequency in cycles per day (cpd). The upper plot shows spectral density of pressure (in mb²/cpd) and sea level (in cm²/cpd); the middle plot shows the squared coherence of the two series; and the lower plot shows the phase.

Multiple regression analysis indicates that monthly anomalies of dynamic height and meridional wind stress account for most of the monthly sea level variability at Monterey during both the Davidson Current and upwelling seasons. Atmospheric pressure and SST account for an additional portion of sea level variability during the upwelling season.

There is good agreement between the behavior of sea level and dynamic height in both a seasonal sense and in interyear variability. The close agreement between sea level and dynamic height, and the high correlation of sea level at Monterey with that at adjacent tide sta-

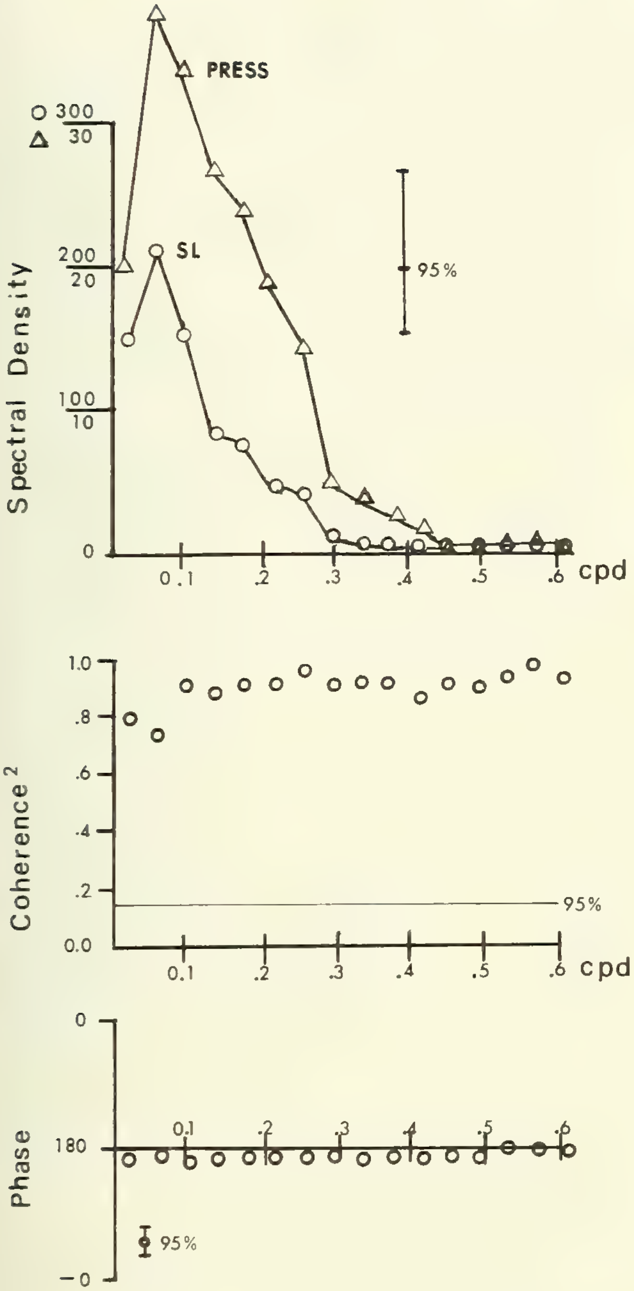

Figure 14.—Spectral plots of 6-h atmospheric pressure (Press) and unadjusted sea level (SL) for the upwelling period (df = 100) at Monterey, Calif. The horizontal axes are frequency in cycles per day (cpd). The upper plot shows spectral density of pressure (in mb²/cpd) and sea level (in cm²/cpd); the middle plot shows the squared coherence of the two series; and the lower plot shows the phase.

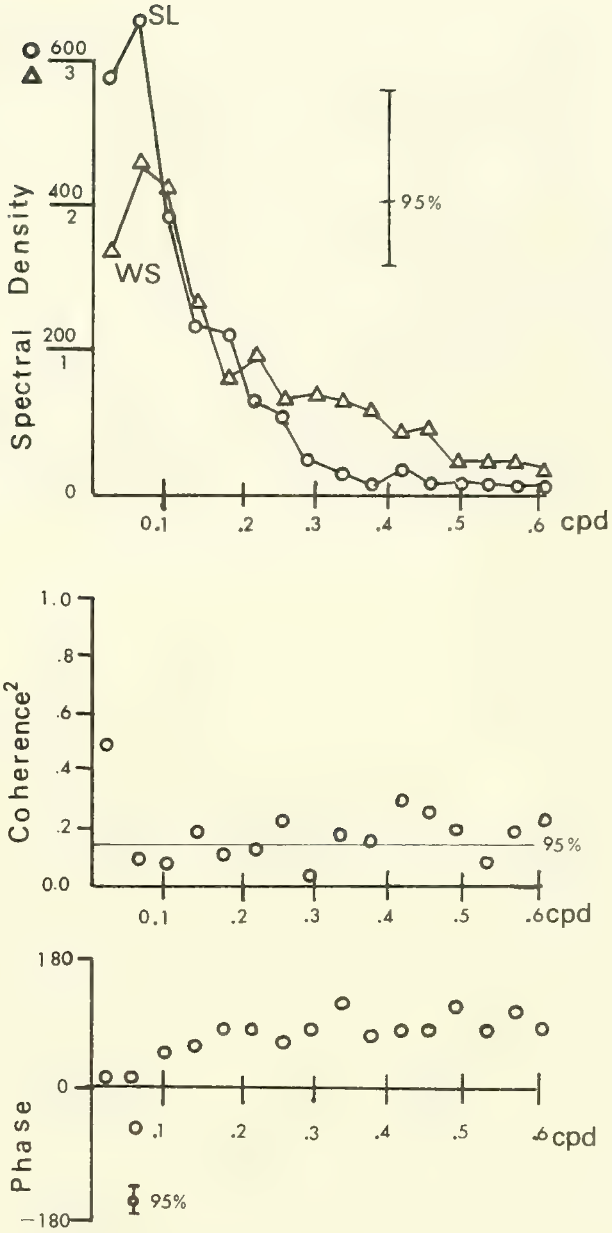

Figure 15.—Spectral plots of 6-h meridional wind stress (WS) and adjusted sea level (SL) for the winter period (df = 90) at Monterey, Calif. The horizontal axes are frequency in cycles per day (cpd). The upper plot shows spectral density of wind stress (in (dynes/cm²)²/cpd) and sea level (in cm²/cpd); the middle plot shows the squared coherence of the two series; and the lower plot shows the phase.

tions along the coast are both thought to result from variations in coastal current flow.

Analysis of 6-h sea level and atmospheric pressure observations shows that the power spectra in the winter season are more energetic than those of the upwelling season, and that most of the energy occurs at low frequencies (periods longer than 12 d). Coherence between sea level and atmospheric pressure is significant and independent of frequency. This and a nearly constant 180° phase relationship between these 6-h data sets reflects the inverse response between sea level and atmospheric pressure expected from the hydrostatic relationship. The power spectra for 6-h meridional wind stress also show a concentration of energy at low frequencies and are most energetic in winter; however, coherence between the local wind stress and sea level is generally low.

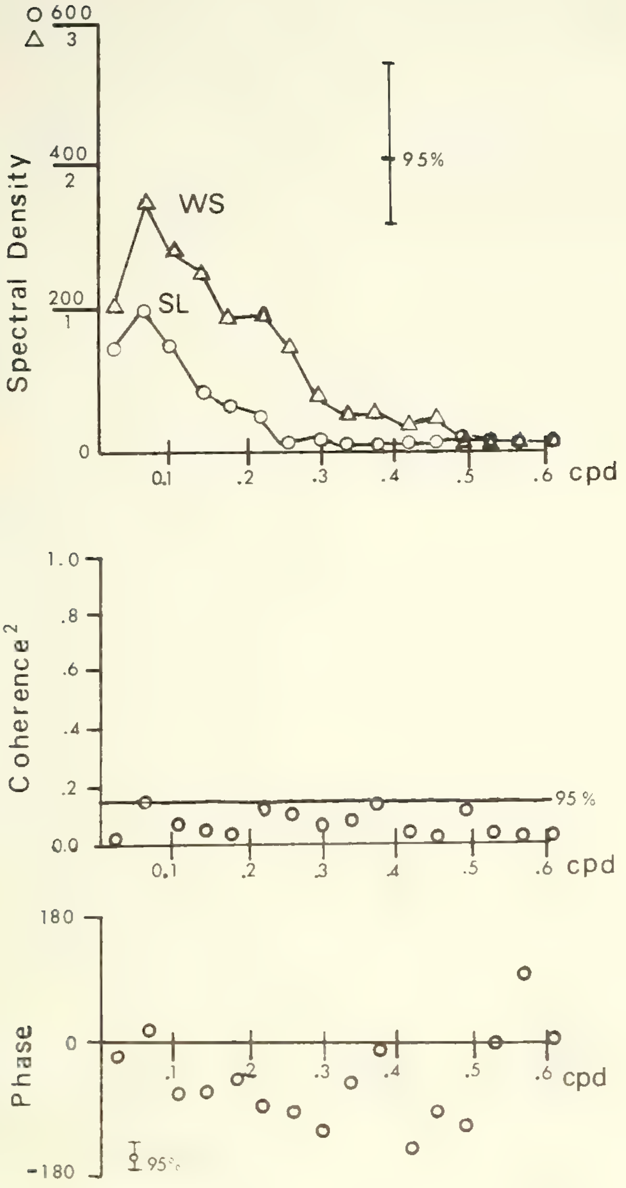

Figure 16.—Spectral plot of 6-h meridional wind stress (WS) and adjusted sea level (SL) for the upwelling period (df = 100) at Monterey, Calif. The horizontal axes are frequency in cycles per day (cpd). The upper plot shows spectral density of wind stress (in (dynes/cm^2)^2/cpd) and sea level (in cm^2/cpd); the middle plot shows the squared coherence of the two series; and the lower plot shows the phase.

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APPENDIX A.—MISSING HOURLY SEA LEVEL DATA

The dates and times of missing hourly sea level observations at Monterey, Calif., are listed below. The data series began 21 July 1963 and ended 31 August 1976.

1963
25 Aug. 12AM-4 Sept. 11PM
28 Sept. 4AM-3 Oct. 6PM
16 Oct. 9AM-21 Oct. 11AM

1964
28 Mar. 12AM-30 Mar. 7PM

1965
1 Apr. 12AM-1 May 9AM
1 Sept. 12AM-31 Dec. 11PM

1966
1 Jan. 12AM-3 Feb. 3PM

1969
20 Sept. 12PM-23 Sept. 3PM

1970
6 Oct. 10PM-8 Oct. 3PM

1971
20 Jan. 7PM-23 Jan. 2PM

1975
14 Feb. 1PM-18 Feb. 3PM
22 Oct. 2AM-28 Oct. 11PM
7 Nov. 1AM-19 Nov. 11PM

1976
25 May 1AM-26 May 11PM

APPENDIX B.—MONTHLY MEAN OCEANIC AND ATMOSPHERIC OBSERVATIONS

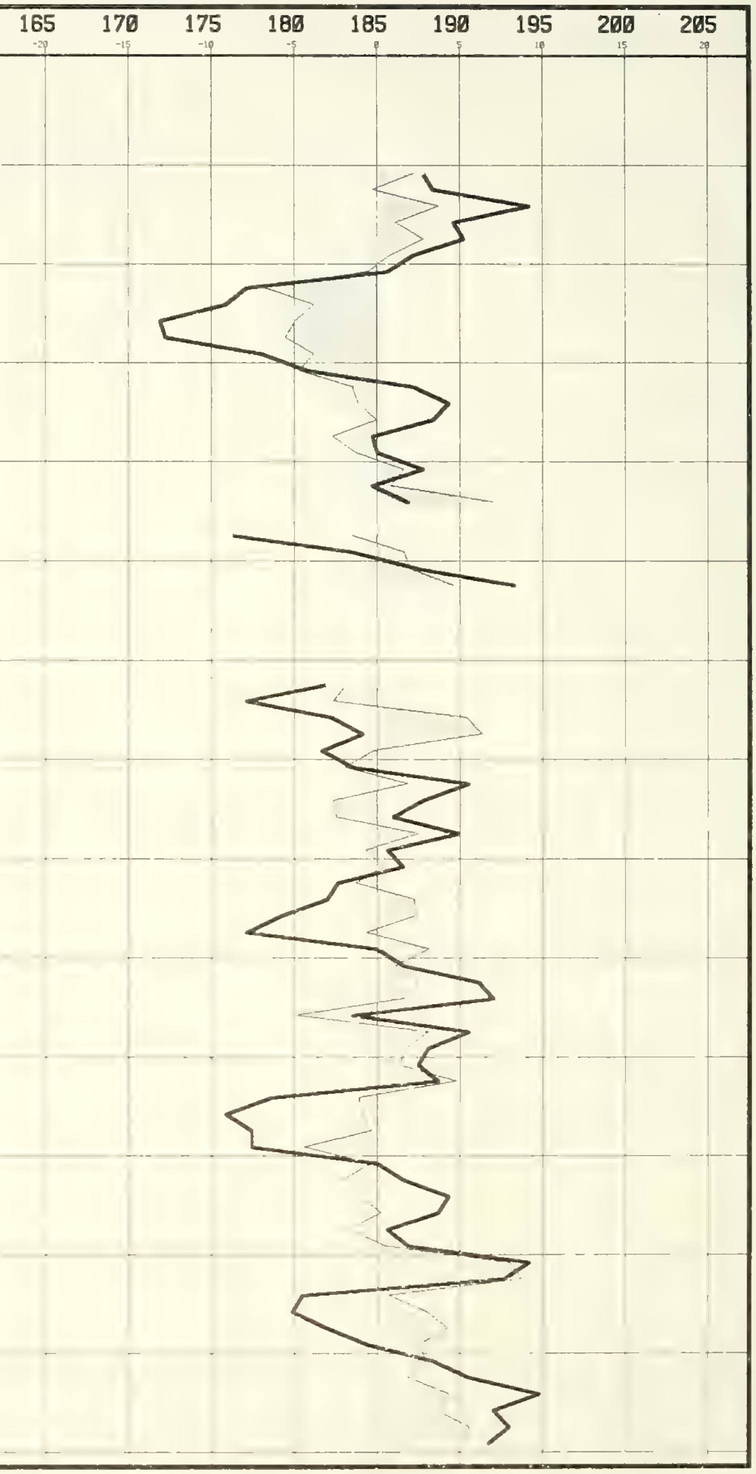
This appendix presents graphical plots of monthly means and monthly mean anomalies of various oceanic and atmospheric observations for the period 1960 to 1978 at Monterey, Calif. Anomalies were calculated as the difference between a monthly mean and the long term mean (1963-78) for the same month. Monthly means are shown as heavy lines and monthly anomalies as light lines. The data are presented in the following sequence:

1) sea level (cm),
2) adjusted sea level (cm),
3) surface atmospheric pressure (mb),
4) meridional wind stress (dynes/cm^2; positive northward),
5) zonal wind stress (dynes/cm^2; positive eastward),
6) offshore/onshore Ekman transport (t/s per 100 m of coastline; positive offshore),
7) Sverdrup transport (t/s per km; positive northward),
8) surface salinity (parts per thousand),
9) sea surface temperature (°C), and
10) dynamic height (cm).

NOAA-NMFS, PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

SEA LEVEL MONTEREY, CA BY MONTH

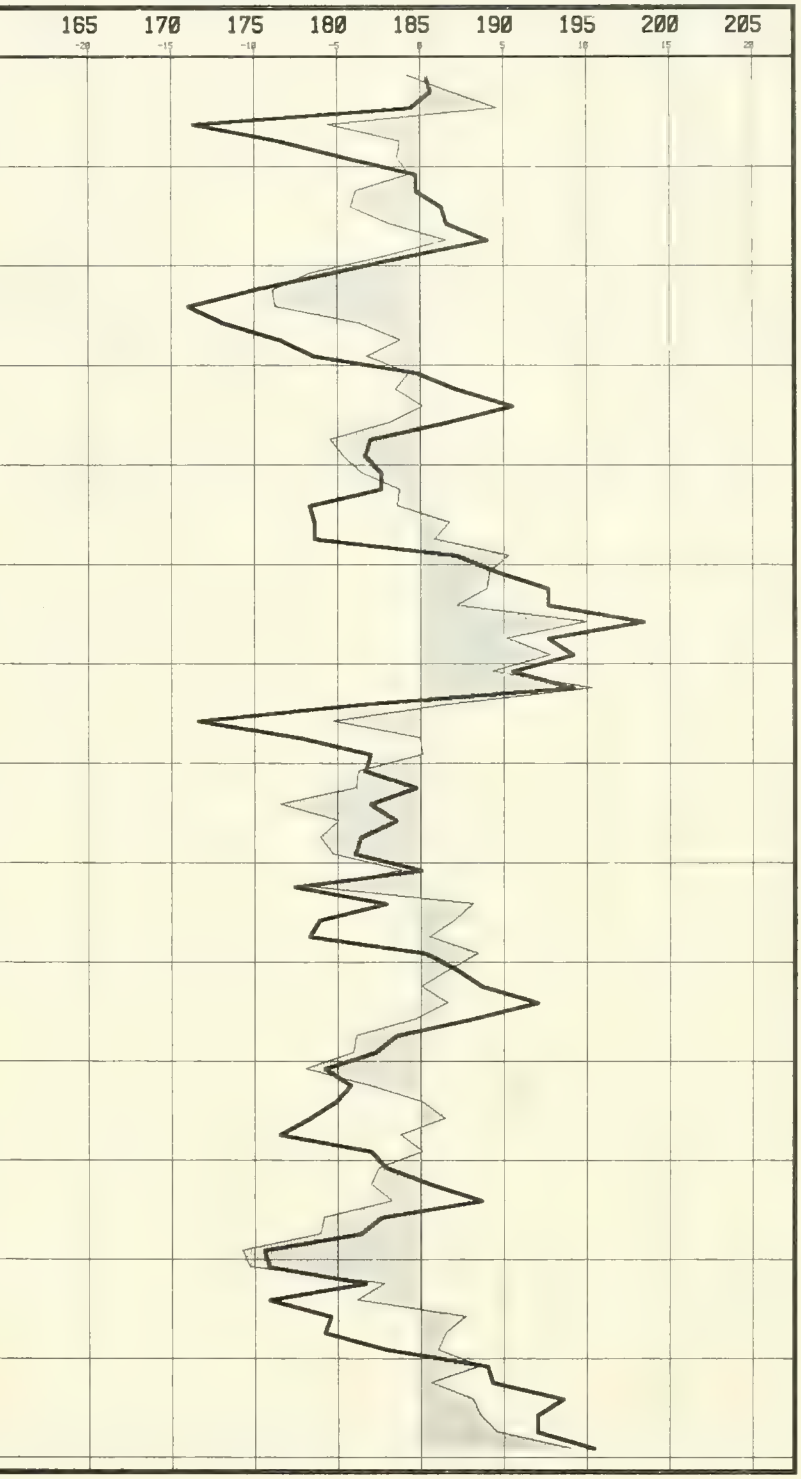
MONTH	VALUE	ANOMALY
196301	NO DATA	
2	NO DATA	
3	NO DATA	
4	NO DATA	
5	NO DATA	
6	NO DATA	
7	187.76	2.32
8	188.37	-.27
9	194.16	3.74
10	189.59	1.16
11	190.20	2.78
12	187.15	.81
196401	185.62	-.54
2	177.09	-6.79
3	175.87	-3.86
4	171.91	-4.94
5	172.21	-5.53
6	178.00	-3.84
7	180.75	-4.69
8	187.15	-1.49
9	189.28	-1.14
10	188.37	-.06
11	184.71	-2.70
12	185.01	-1.32
196501	187.76	1.59
2	184.71	.83
3	186.84	7.11
4	NO DATA	
5	176.17	-1.56
6	183.49	1.65
7	187.45	2.02
8	193.24	4.61
9	NO DATA	
10	NO DATA	
11	NO DATA	
12	NO DATA	
196601	NO DATA	
2	181.97	-1.91
3	177.09	-2.64
4	182.27	5.42
5	184.10	6.36
6	181.66	-.18
7	183.49	-1.94
8	190.50	1.87
9	187.76	-2.66
10	185.93	-2.50
11	189.89	2.48
12	185.62	-.71
196701	186.54	.37
2	182.58	-1.30
3	181.97	2.24
4	179.22	2.37
5	177.09	-.65
6	185.01	3.17
7	186.54	1.10
8	191.11	2.48
9	192.02	1.61
10	183.49	-4.94
11	190.50	3.09
12	188.06	1.73
196801	187.45	1.28
2	188.67	4.80
3	178.61	-1.12
4	175.87	-.98
5	177.39	-.35
6	177.39	-4.45
7	185.01	-.42
8	186.54	-2.10
9	189.28	-1.14
10	188.67	.24
11	185.62	-1.79
12	186.84	.51
196901	194.16	7.99
2	192.63	8.76
3	180.44	.71
4	179.83	2.98
5	181.97	4.23
6	184.40	2.56
7	188.37	2.93
8	190.50	1.87
9	194.77	4.35
10	192.02	3.60
11	192.94	5.53
12	191.72	5.38



NOAA-NMFS, PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

SEA LEVEL MONTEREY, CA BY MONTH

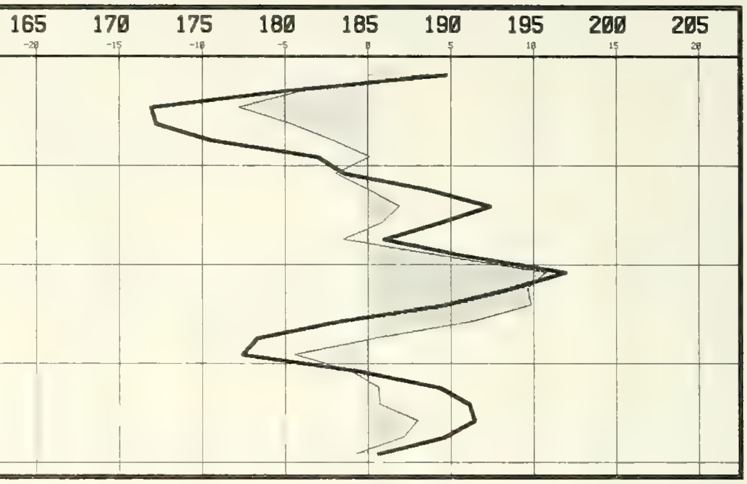
MONTH	VALUE	ANOMALY
197001	185.32	-.85
2	185.62	1.75
3	184.40	4.67
4	171.30	-5.55
5	176.48	-1.26
6	180.44	-1.40
7	184.71	-.72
8	184.71	-3.92
9	186.23	-4.19
10	186.54	-1.89
11	188.98	1.56
12	184.10	-2.24
197101	179.53	-6.64
2	174.96	-8.92
3	170.99	-8.74
4	173.13	-3.72
5	176.48	-1.26
6	178.61	-3.23
7	184.71	-.72
8	187.15	-1.49
9	190.50	.08
10	186.54	-1.89
11	181.97	-5.45
12	181.66	-4.67
197201	182.58	-3.59
2	182.58	-1.30
3	178.31	-1.42
4	178.61	1.76
5	178.61	.87
6	187.15	5.30
7	189.59	4.15
8	192.63	4.00
9	192.63	2.21
10	198.42	10.00
11	192.63	5.22
12	194.16	7.82
197301	190.50	4.33
2	194.16	10.28
3	181.36	1.63
4	171.60	-5.25
5	177.70	-.04
6	181.97	.12
7	181.66	-3.77
8	184.71	-3.92
9	181.97	-8.45
10	183.49	-4.94
11	181.36	-6.06
12	181.05	-5.28
197401	185.01	-1.15
2	177.39	-6.48
3	182.88	3.15
4	178.92	2.07
5	178.31	.57
6	185.32	3.47
7	187.15	1.71
8	188.67	.04
9	192.02	1.61
10	188.06	-.37
11	183.49	-3.92
12	182.27	-4.06
197501	179.22	-6.95
2	180.75	-3.13
3	179.83	.10
4	178.31	1.46
5	176.48	-1.26
6	181.97	.12
7	182.88	-2.55
8	185.62	-3.01
9	188.67	-1.75
10	182.58	-5.85
11	181.36	-6.06
12	175.56	-10.77
197601	175.87	-10.30
2	181.66	-2.21
3	175.87	-3.86
4	179.53	2.68
5	179.22	1.48
6	182.88	1.04
7	188.98	3.54
8	189.28	.65
9	193.55	3.13
10	192.02	3.60
11	192.02	4.61
12	195.38	9.04



NOAA-NMFS, PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

SEA LEVEL MONTEREY, CA BY MONTH

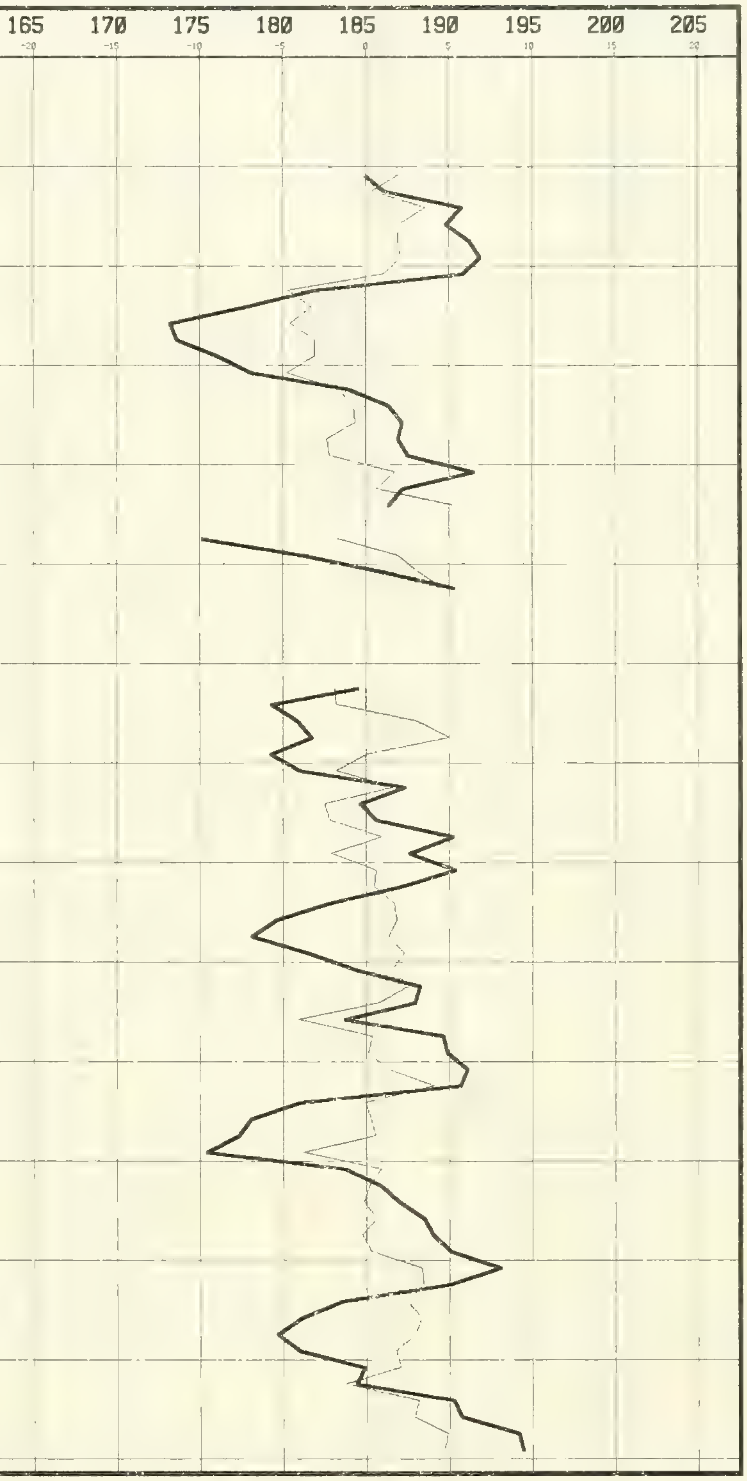
MONTH	VALUE	ANOMALY
197701	189.89	3.72
2	179.83	-4.04
3	171.91	-7.82
4	172.21	-4.64
5	175.56	-2.17
6	181.97	.12
7	183.49	-1.94
8	188.67	.04
9	192.33	1.91
10	189.28	.85
11	185.93	-1.48
12	190.80	4.47
197801	196.90	10.73
2	193.55	9.67
3	189.59	9.86
4	183.18	6.34
5	178.31	.57
6	177.39	-4.45
7	184.40	-1.03
8	189.28	.65
9	191.11	.69
10	191.41	2.99
11	189.59	2.17
12	185.62	-.71



NOAA-NMFS, PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

ADJ. SEA LEVEL MONTEREY, CA BY MONTH

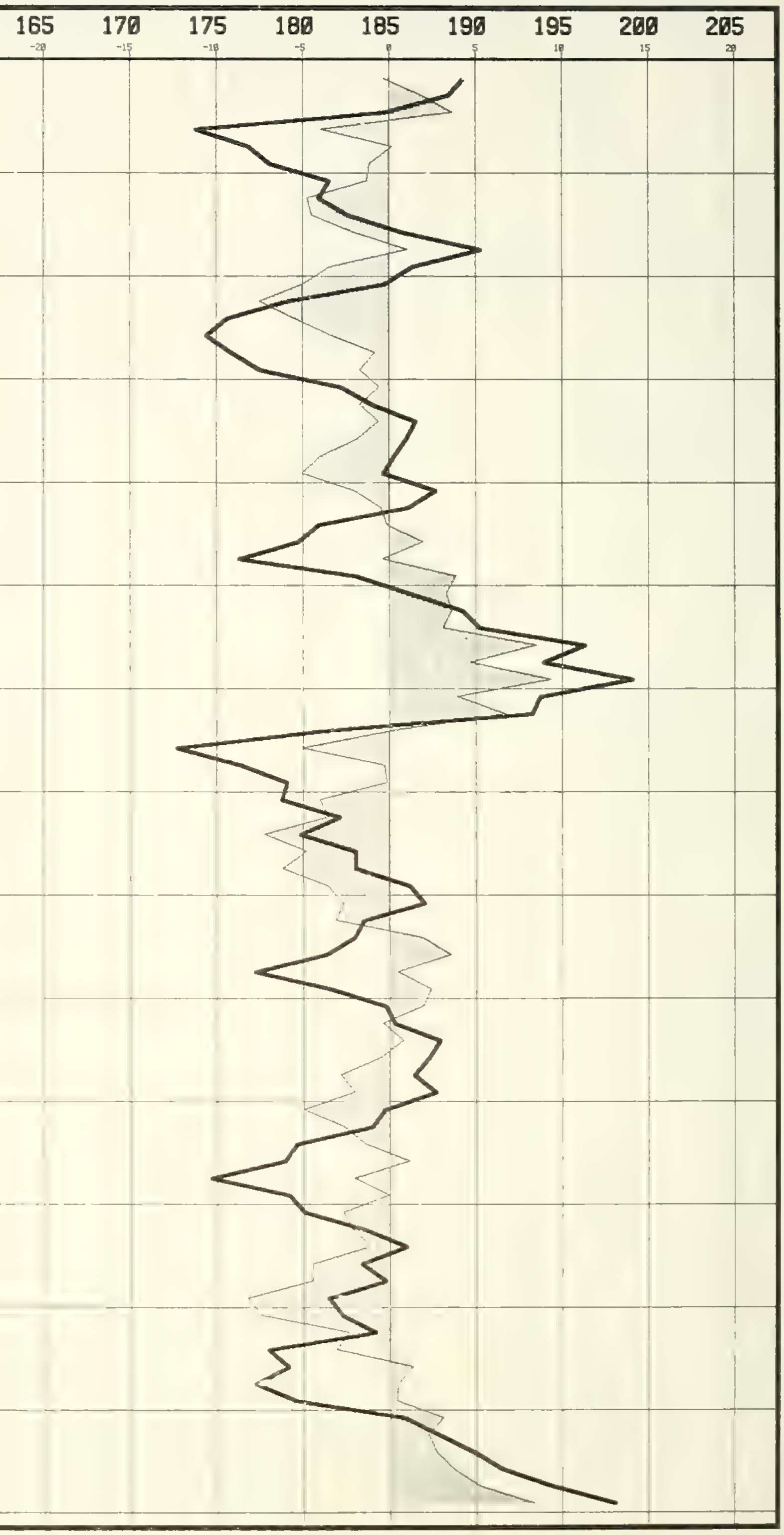
MONTH	VALUE	ANOMALY
196301	NO DATA	
2	NO DATA	
3	NO DATA	
4	NO DATA	
5	NO DATA	
6	NO DATA	
7	184.85	2.06
8	186.06	.42
9	190.75	3.62
10	189.78	1.98
11	191.19	1.95
12	191.84	2.12
196401	190.81	1.09
2	181.88	-4.69
3	177.76	-3.30
4	173.20	-4.56
5	173.60	-3.11
6	176.09	-3.10
7	178.04	-4.75
8	183.94	-1.70
9	186.37	-.76
10	187.16	-.64
11	186.90	-2.34
12	187.50	-2.22
196501	191.45	1.73
2	187.20	.63
3	186.33	5.27
4	NO DATA	
5	174.97	-1.74
6	181.08	1.89
7	185.94	3.15
8	190.23	4.59
9	NO DATA	
10	NO DATA	
11	NO DATA	
12	NO DATA	
196601	NO DATA	
2	184.66	-1.91
3	179.28	-1.78
4	180.86	3.10
5	181.69	4.98
6	179.25	.06
7	180.98	-1.81
8	187.29	1.65
9	184.65	-2.48
10	185.62	-2.18
11	190.18	.94
12	187.61	-2.11
196701	190.33	.61
2	187.07	.50
3	182.76	1.70
4	179.61	1.85
5	178.08	1.37
6	181.50	2.31
7	184.33	1.54
8	188.20	2.56
9	187.92	.79
10	183.68	-4.12
11	189.59	.35
12	189.85	.13
196801	191.04	1.32
2	190.66	4.09
3	181.00	-.06
4	178.06	.30
5	177.28	.57
6	175.38	-3.81
7	183.70	.91
8	185.83	.19
9	186.97	-.16
10	188.46	.66
11	189.01	-.23
12	190.03	.31
196901	193.05	3.33
2	190.02	3.45
3	183.53	2.47
4	181.12	3.36
5	179.66	2.95
6	181.00	1.81
7	184.86	2.07
8	184.39	-1.25
9	190.26	3.13
10	190.72	2.92
11	194.13	4.89
12	194.41	4.69



NOAA-NMFS.PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

ADJ SEA LEVEL MONTEREY, CA BY MONTH

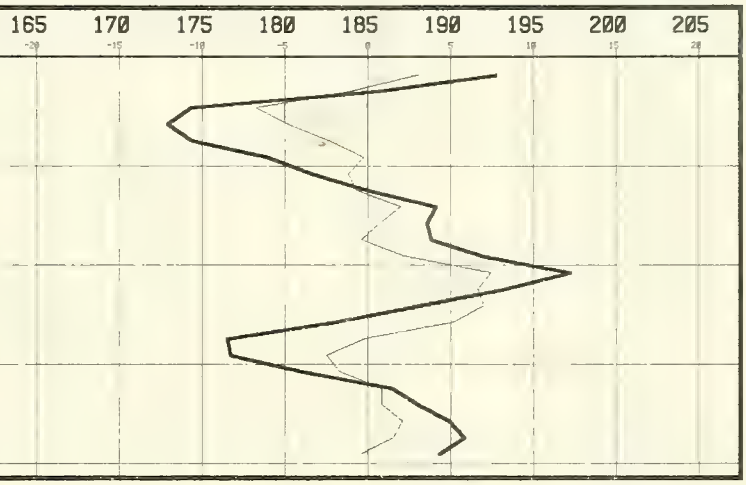
MONTH	VALUE	ANOMALY
197001	189.31	-.41
2	188.41	1.84
3	184.70	3.64
4	173.79	-3.97
5	176.87	.16
6	178.03	-1.16
7	181.50	-1.29
8	180.90	-4.74
9	182.62	-4.51
10	185.73	-2.07
11	190.27	1.03
12	186.29	-3.43
197101	184.72	-5.00
2	179.05	-7.52
3	175.58	-5.48
4	174.42	-3.34
5	175.87	-.84
6	177.50	-1.69
7	182.20	-.59
8	183.94	-1.70
9	186.49	-.64
10	185.93	-1.87
11	185.26	-3.98
12	184.65	-5.07
197201	187.67	-2.05
2	186.07	-.50
3	180.90	-.16
4	179.70	1.94
5	176.30	-.41
6	183.04	3.85
7	186.08	3.29
8	189.22	3.58
9	190.22	3.09
10	196.32	8.52
11	193.92	4.68
12	199.05	9.33
197301	193.69	3.97
2	193.25	6.68
3	181.15	.09
4	172.69	-5.07
5	176.39	-.32
6	179.06	-.13
7	178.75	-4.04
8	182.10	-3.54
9	179.86	-7.27
10	182.98	-4.82
11	183.05	-6.19
12	186.14	-3.58
197401	187.00	-2.72
2	183.48	-3.09
3	182.97	1.91
4	181.31	3.55
5	177.20	.49
6	181.61	2.42
7	184.74	1.95
8	185.26	-.38
9	187.92	.79
10	187.25	-.55
11	186.38	-2.86
12	187.66	-2.06
197501	184.71	-5.01
2	183.94	-2.63
3	179.62	-1.44
4	178.90	1.14
5	174.67	-2.04
6	179.16	-.03
7	180.07	-2.72
8	183.51	-2.13
9	185.96	-1.17
10	183.37	-4.43
11	184.74	-4.50
12	181.46	-8.26
197601	182.26	-7.46
2	184.15	-2.42
3	177.96	-3.10
4	179.12	1.36
5	177.21	.50
6	179.57	.36
7	185.87	3.09
8	187.37	2.23
9	189.84	2.71
10	191.52	3.72
11	194.42	5.18
12	198.07	8.35



NOAA-NMFS,PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

ADJ. SEA LEVEL MONTEREY, CA BY MONTH

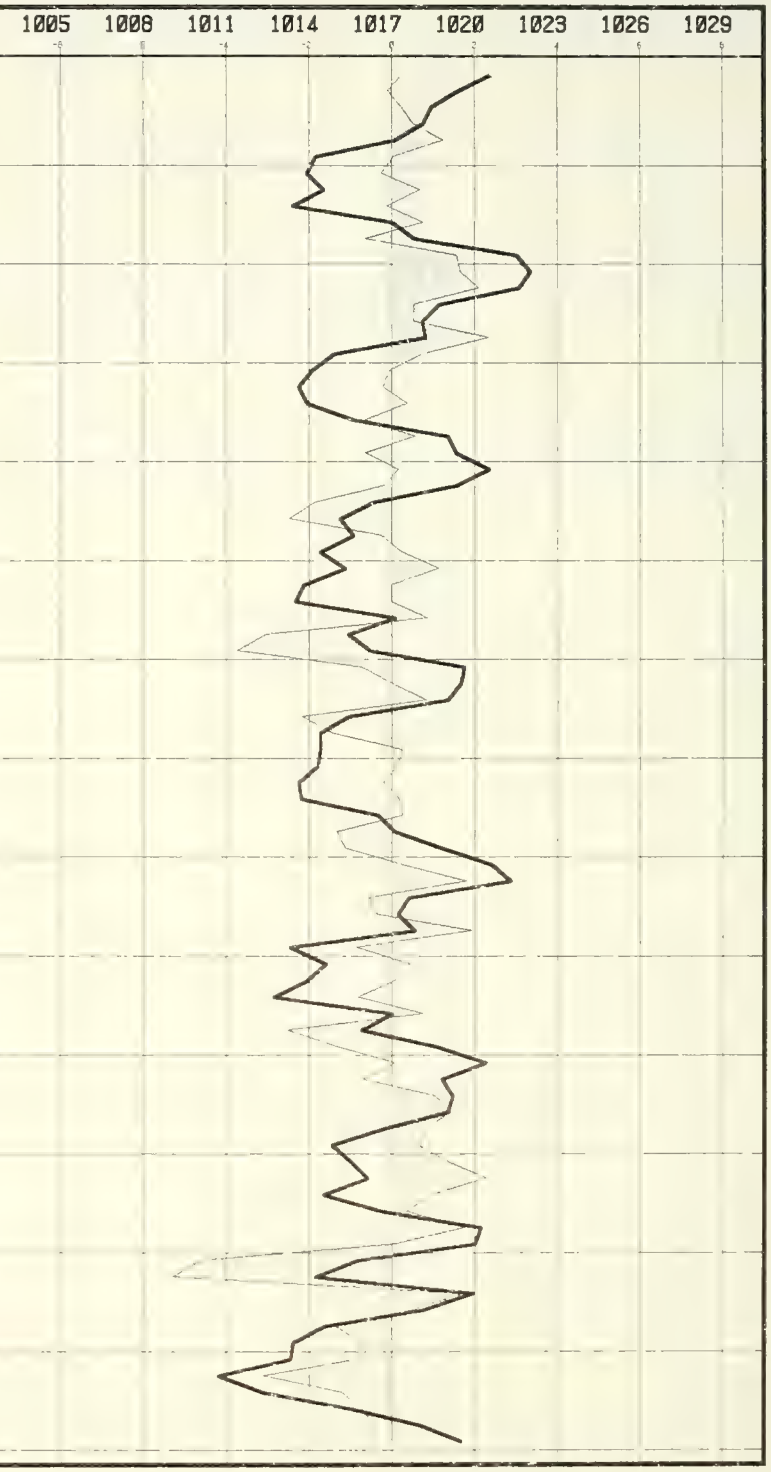
MONTH	VALUE	ANOMALY
197701	192.88	3.16
2	185.52	-1.05
3	174.30	-6.76
4	172.90	-4.86
5	174.36	-2.35
6	178.96	-.23
7	181.58	-1.21
8	184.96	-.68
9	189.12	1.99
10	188.57	.77
11	188.82	-.42
12	191.90	2.18
197801	197.19	7.47
2	193.24	6.67
3	188.08	7.02
4	182.98	5.22
5	176.50	-.21
6	176.68	-2.51
7	181.10	-1.69
8	186.47	.83
9	188.00	.87
10	189.91	2.11
11	190.78	1.54
12	189.31	-.41



PRESSURE

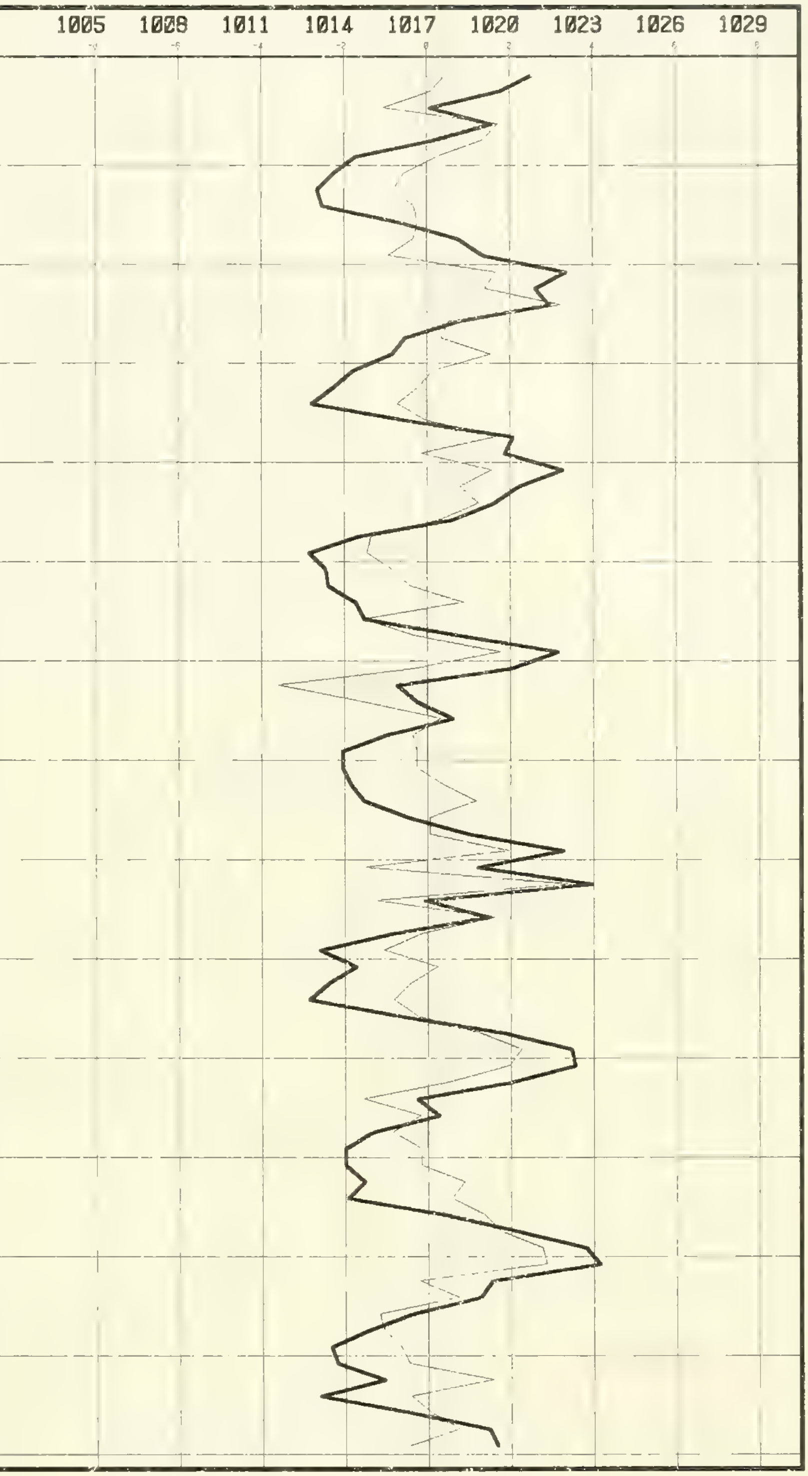
BY MONTH

MONTH	VALUE	ANOMALY
196301	1020.60	.27
2	1019.40	-.10
3	1018.40	.24
4	1018.10	.52
5	1017.10	1.24
6	1014.20	.04
7	1013.90	-.26
8	1014.50	.69
9	1013.40	-.12
10	1017.00	.76
11	1017.80	-.64
12	1021.50	1.56
196401	1022.00	1.67
2	1021.60	2.10
3	1018.70	.54
4	1018.10	.52
5	1018.20	2.34
6	1014.90	.74
7	1014.10	-.06
8	1013.60	-.21
9	1013.90	.38
10	1015.60	-.64
11	1019.00	.56
12	1019.30	-.64
196501	1020.50	.17
2	1019.30	-.20
3	1016.30	-1.86
4	1015.10	-2.48
5	1015.60	-.26
6	1014.40	.24
7	1015.30	1.14
8	1013.80	-.01
9	1013.50	-.02
10	1017.10	.86
11	1015.40	-3.04
12	1016.20	-3.74
196601	1019.60	-.73
2	1019.50	.00
3	1019.00	.84
4	1015.40	-2.18
5	1014.40	-1.46
6	1014.40	.24
7	1014.30	.14
8	1013.60	-.21
9	1013.70	.18
10	1016.50	.26
11	1017.10	-1.34
12	1018.80	-1.14
196701	1020.60	.27
2	1021.30	1.80
3	1017.60	-.56
4	1017.20	-.38
5	1017.80	1.94
6	1013.30	-.86
7	1014.60	.44
8	1013.90	.09
9	1012.70	-.82
10	1017.00	.76
11	1015.90	-2.54
12	1018.60	-1.34
196801	1020.40	.07
2	1018.80	-.70
3	1019.20	1.04
4	1019.00	1.42
5	1016.70	.84
6	1014.80	.64
7	1015.50	1.34
8	1016.10	2.29
9	1014.50	.98
10	1016.60	.36
11	1020.20	1.76
12	1020.00	.06
196901	1015.70	-4.63
2	1014.20	-5.30
3	1019.90	1.74
4	1018.10	.52
5	1014.50	-1.36
6	1013.40	-.76
7	1013.30	-.86
8	1010.70	-3.11
9	1012.30	-1.22
10	1015.50	-.74
11	1018.00	-.44
12	1019.50	-.44



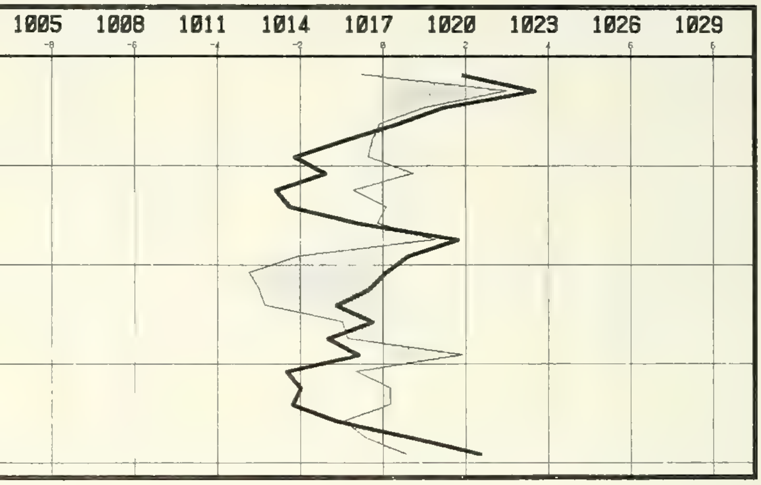
PRESSURE BY MONTH

MONTH	VALUE	ANOMALY
197001	1020.80	.47
2	1019.60	.10
3	1017.10	-1.06
4	1019.30	1.72
5	1017.20	1.34
6	1014.40	.24
7	1013.60	-.56
8	1013.00	-.81
9	1013.20	-.32
10	1016.00	-.24
11	1018.10	-.34
12	1019.00	-.94
197101	1022.00	1.67
2	1020.90	1.40
3	1021.40	3.24
4	1018.10	.52
5	1016.20	.34
6	1015.70	1.54
7	1014.30	.14
8	1013.60	-.21
9	1012.80	-.72
10	1016.20	-.04
11	1020.10	1.66
12	1019.80	-.14
197201	1021.90	1.57
2	1020.30	.80
3	1019.40	1.24
4	1017.90	.32
5	1014.50	-1.36
6	1012.70	-1.46
7	1013.30	-.86
8	1013.40	-.41
9	1014.40	.88
10	1014.70	-1.54
11	1018.10	-.34
12	1021.70	1.76
197301	1020.00	-.33
2	1015.90	-3.60
3	1016.60	-1.56
4	1017.90	.32
5	1015.50	-.36
6	1013.90	-.26
7	1013.90	-.26
8	1014.20	.39
9	1014.70	1.18
10	1016.30	.06
11	1018.50	.06
12	1021.90	1.96
197401	1018.80	-1.53
2	1022.90	3.40
3	1016.90	-1.26
4	1019.20	1.62
5	1015.70	-.16
6	1013.10	-1.06
7	1014.40	.24
8	1013.40	-.41
9	1012.70	-.82
10	1016.00	-.24
11	1019.70	1.26
12	1022.20	2.26
197501	1022.30	1.97
2	1020.00	.50
3	1016.60	-1.56
4	1017.40	-.18
5	1015.00	-.86
6	1014.00	-.16
7	1014.00	-.16
8	1014.70	.89
9	1014.10	.58
10	1017.60	1.36
11	1020.20	1.76
12	1022.70	2.75
197601	1023.20	2.87
2	1019.30	-.20
3	1018.90	.74
4	1016.40	-1.18
5	1014.80	-1.06
6	1013.50	-.66
7	1013.70	-.46
8	1015.40	1.59
9	1013.10	-.42
10	1016.30	.06
11	1019.20	.76
12	1019.50	-.44



PRESSURE BY MONTH

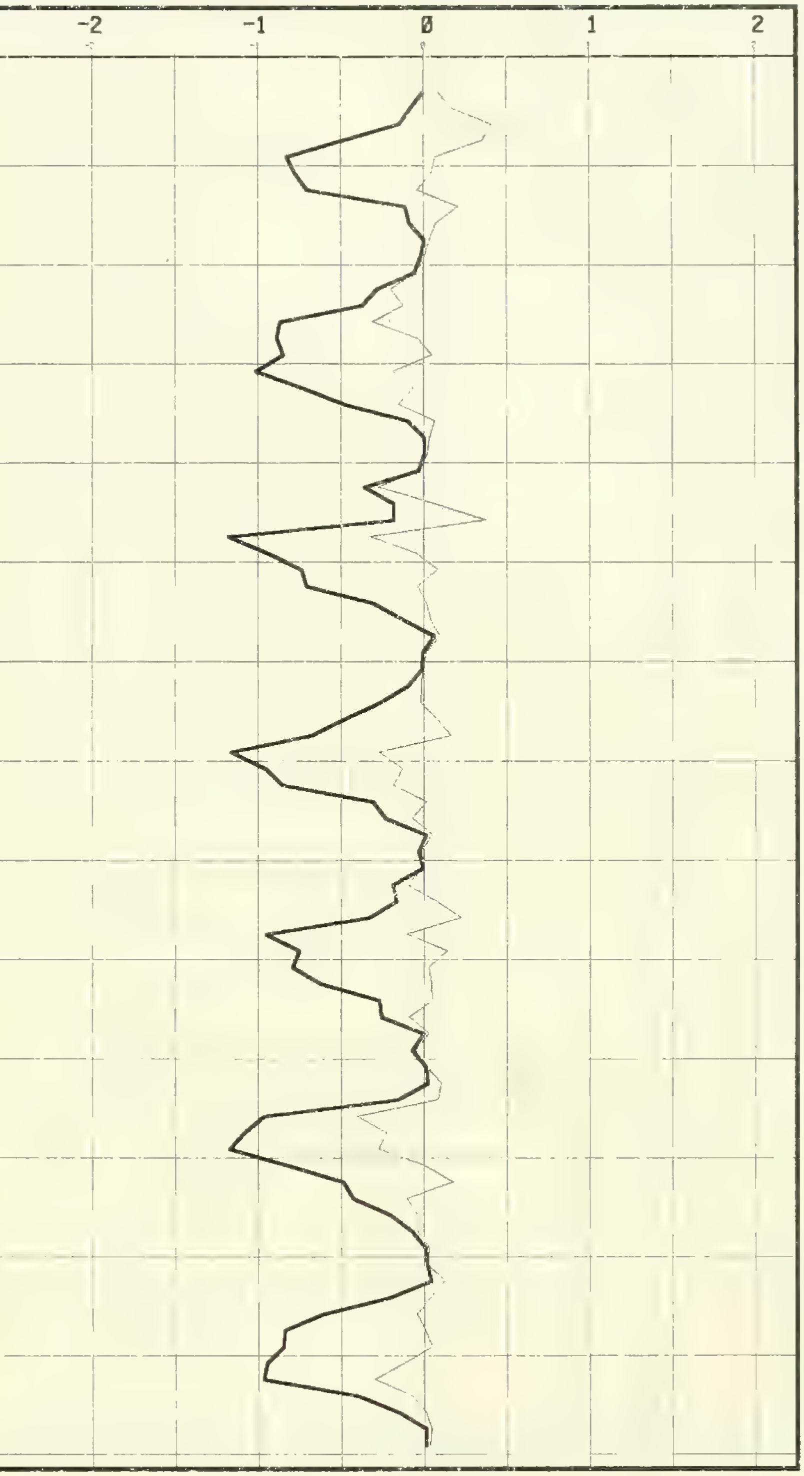
MONTH	VALUE	ANOMALY
197701	1019.80	-.53
2	1022.50	3.00
3	1019.20	1.04
4	1017.50	-.08
5	1015.60	-.26
6	1013.80	-.36
7	1014.90	.74
8	1013.10	-.71
9	1013.60	.08
10	1016.10	-.14
11	1019.70	1.26
12	1017.90	-2.04
197801	1017.10	-3.23
2	1016.50	-3.00
3	1015.30	-2.86
4	1016.60	-.98
5	1015.00	-.86
6	1016.10	1.94
7	1013.50	-.66
8	1014.00	.19
9	1013.70	.18
10	1015.30	-.94
11	1018.00	-.44
12	1020.50	.56



NOAA-NMFS.PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

N. COMP. WIND STRESS BY MONTH

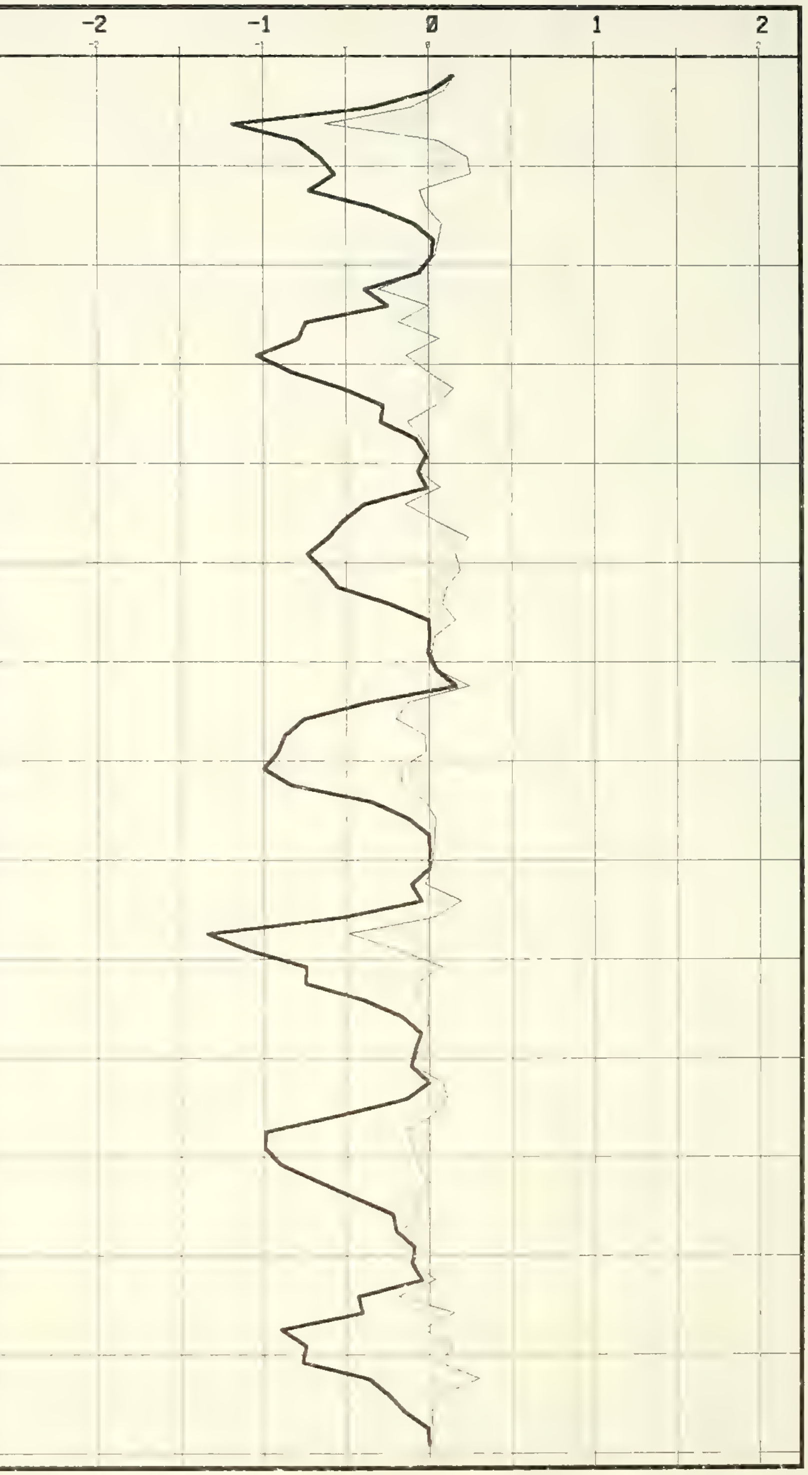
MONTH	VALUE	ANOMALY
196301	-.05	-.05
2	0.00	.08
3	-.08	.17
4	-.15	.41
5	-.50	.36
6	-.83	.07
7	-.78	.05
8	-.71	-.04
9	-.11	.21
10	-.09	.08
11	0.00	.04
12	-.02	.01
196401	-.06	-.05
2	-.29	-.20
3	-.37	-.13
4	-.87	-.31
5	-.89	-.04
6	-.85	.05
7	-1.01	-.19
8	-.73	-.07
9	-.48	-.16
10	-.10	.07
11	0.00	.04
12	-.00	.02
196501	-.04	-.03
2	-.36	-.28
3	-.19	.06
4	-.18	.38
5	-1.18	-.33
6	-.95	-.05
7	-.74	.09
8	-.71	-.04
9	-.31	.02
10	-.13	.04
11	.06	.10
12	-.01	.02
196601	-.02	-.01
2	-.10	-.02
3	-.27	-.02
4	-.48	.08
5	-.69	.17
6	-1.17	-.27
7	-.96	-.13
8	-.85	-.19
9	-.31	.01
10	-.24	-.07
11	.01	.05
12	-.04	-.01
196701	-.01	-.01
2	-.19	-.11
3	-.17	.08
4	-.34	.22
5	-.95	-.10
6	-.76	.14
7	-.80	.03
8	-.62	.04
9	-.27	.05
10	-.26	-.09
11	-.01	.03
12	-.08	-.05
196801	.01	.02
2	.02	.11
3	-.16	.09
4	-.96	-.40
5	-1.08	-.23
6	-1.17	-.28
7	-.82	.00
8	-.49	.18
9	-.43	-.11
10	-.21	-.04
11	-.08	-.04
12	.01	.03
196901	.02	.02
2	.04	.13
3	-.21	.04
4	-.61	-.05
5	-.84	.01
6	-.85	.05
7	-.95	-.12
8	-.97	-.30
9	-.40	-.08
10	-.16	.01
11	.01	.05
12	.01	.03



NOAA-NMFS. PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

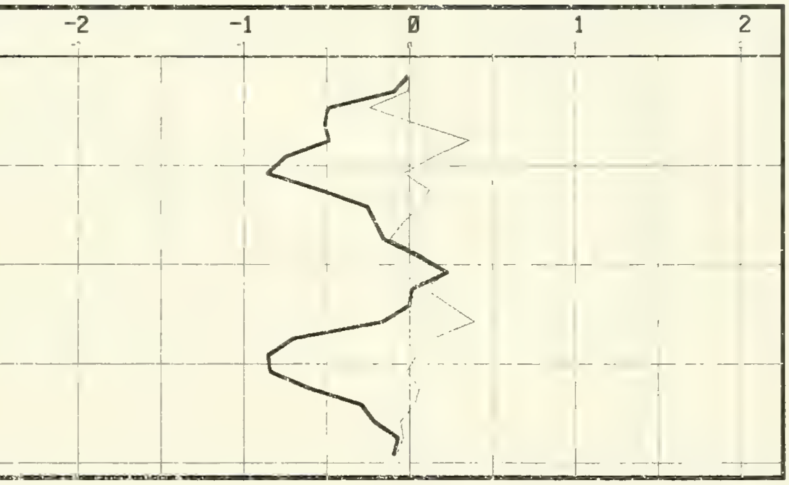
N. COMP. WIND STRESS BY MONTH

MONTH	VALUE	ANOMALY
197001	.16	.16
2	.01	.10
3	-.36	-.11
4	-1.19	-.63
5	-.79	.06
6	-.66	.24
7	-.57	.26
8	-.72	-.06
9	-.34	-.02
10	-.09	.08
11	.02	.06
12	.01	.04
197101	-.06	-.06
2	-.39	-.31
3	-.25	-.00
4	-.74	-.18
5	-.79	.06
6	-1.04	-.14
7	-.83	-.00
8	-.52	.15
9	-.28	.05
10	-.30	-.13
11	-.09	-.05
12	-.02	.00
197201	-.07	-.06
2	-.02	.07
3	-.39	-.15
4	-.52	.04
5	-.61	.24
6	-.74	.16
7	-.64	.19
8	-.56	.11
9	-.24	.08
10	-.01	.16
11	.00	.04
12	-.01	.02
197301	.04	.04
2	.16	.25
3	-.38	-.13
4	-.76	-.20
5	-.88	-.02
6	-.92	-.02
7	-1.00	-.18
8	-.83	-.17
9	-.35	-.02
10	-.13	.04
11	-.00	.03
12	.00	.03
197401	.00	.01
2	-.11	-.02
3	-.05	.20
4	-.53	.03
5	-1.34	-.49
6	-1.09	-.19
7	-.75	.08
8	-.75	-.08
9	-.40	-.07
10	-.17	-.00
11	-.06	-.02
12	-.09	-.07
197501	-.12	-.11
2	-.00	.08
3	-.14	.11
4	-.54	.02
5	-.99	-.14
6	-1.00	-.10
7	-.90	-.07
8	-.68	-.01
9	-.46	-.13
10	-.23	-.06
11	-.21	-.17
12	-.10	-.07
197601	-.11	-.10
2	-.05	.03
3	-.44	-.19
4	-.41	.15
5	-.90	-.05
6	-.75	.15
7	-.77	.05
8	-.37	.30
9	-.25	.07
10	-.16	.01
11	-.02	.02
12	-.01	.02



N. COMP. WIND STRESS BY MONTH

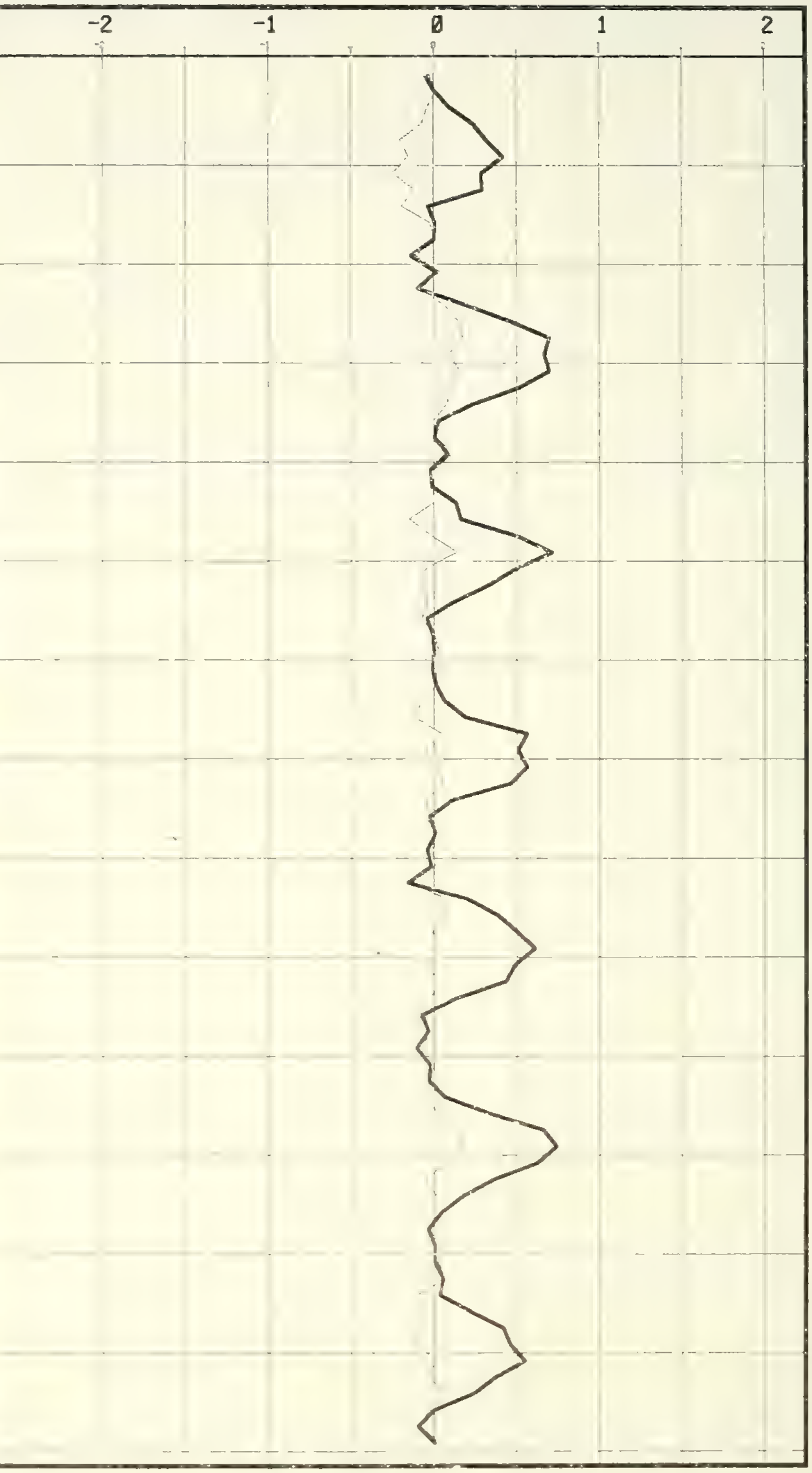
MONTH	VALUE	ANOMALY
197701	-.01	.00
2	-.10	-.01
3	-.49	-.25
4	-.52	.05
5	-.49	.36
6	-.76	.14
7	-.86	-.03
8	-.55	.12
9	-.26	.06
10	-.21	-.04
11	-.16	-.12
12	.05	.07
197801	.22	.23
2	.01	.09
3	-.01	.24
4	-.17	.39
5	-.70	.15
6	-.85	.04
7	-.85	-.02
8	-.61	.06
9	-.30	.03
10	-.22	-.05
11	-.08	-.04
12	-.10	-.08



NOAA-NMFS.PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

EAST COMP. WIND STRESS BY MONTH

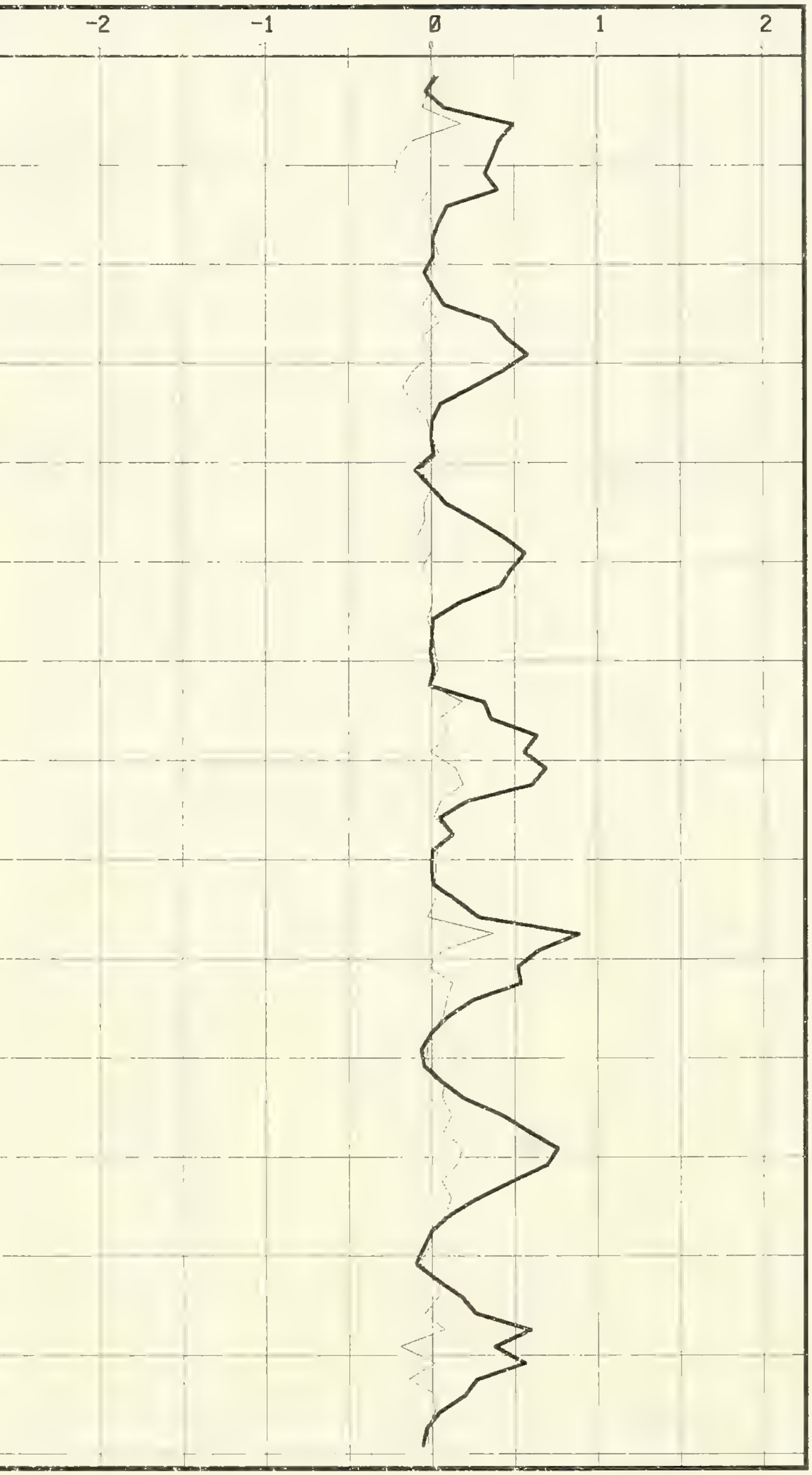
MONTH	VALUE	ANOMALY
196301	-.06	-.03
2	.00	.01
3	.09	-.04
4	.23	-.07
5	.31	-.20
6	.41	-.16
7	.29	-.25
8	.29	-.12
9	-.04	-.19
10	.00	-.02
11	0.00	.01
12	-.14	-.11
196401	.01	.04
2	-.10	-.09
3	.19	.06
4	.45	.15
5	.69	.18
6	.66	.09
7	.70	.16
8	.52	.10
9	.24	.08
10	.03	-.00
11	0.00	.01
12	.08	.11
196501	-.03	-.00
2	-.01	-.00
3	.13	-.00
4	.16	-.15
5	.50	-.02
6	.71	.14
7	.49	-.05
8	.33	-.09
9	.12	-.04
10	-.05	-.07
11	-.01	.00
12	-.00	.03
196601	-.02	.01
2	.01	.02
3	.06	-.07
4	.18	-.12
5	.56	.04
6	.51	-.06
7	.56	.02
8	.46	.05
9	.11	-.05
10	-.03	-.05
11	.01	.02
12	-.05	-.01
196701	-.02	.01
2	-.16	-.15
3	.21	.07
4	.38	.08
5	.50	-.01
6	.61	.04
7	.49	-.05
8	.43	.02
9	.14	-.02
10	-.07	-.10
11	-.04	-.03
12	-.11	-.07
196801	-.03	-.00
2	-.03	-.02
3	.06	-.07
4	.33	.02
5	.65	.14
6	.74	.17
7	.62	.08
8	.35	.06
9	.17	.01
10	.04	.01
11	-.04	-.03
12	.00	.04
196901	.00	.03
2	.05	.06
3	.03	-.10
4	.22	-.09
5	.41	-.10
6	.45	-.11
7	.55	.01
8	.37	-.04
9	.24	.08
10	-.00	-.03
11	-.10	-.09
12	-.00	.03



NOAA-NMFS, PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

EAST COMP. WIND STRESS BY MONTH

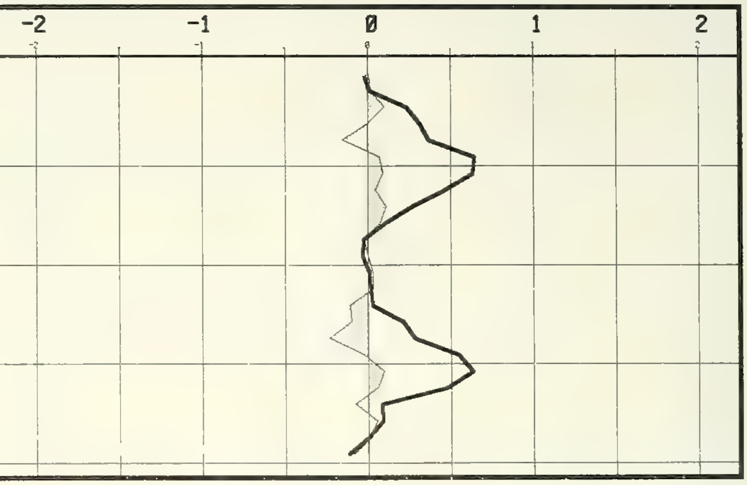
MONTH	VALUE	ANOMALY
197001	.03	.06
2	-.03	-.02
3	.08	-.05
4	.49	.18
5	.41	-.11
6	.36	-.20
7	.32	-.22
8	.40	-.02
9	.09	-.07
10	.04	.01
11	.01	.01
12	.01	.05
197101	-.04	-.02
2	.01	.02
3	.08	-.05
4	.36	.06
5	.45	-.07
6	.57	.00
7	.43	-.11
8	.24	-.17
9	.05	-.11
10	0.00	-.03
11	-.01	.00
12	.01	.04
197201	-.10	-.07
2	-.01	.00
3	.09	-.05
4	.27	-.04
5	.43	-.08
6	.56	-.01
7	.47	-.06
8	.41	-.00
9	.17	.01
10	.00	-.02
11	-.00	.01
12	-.01	.02
197301	.01	.04
2	-.01	-.00
3	.32	.19
4	.36	.05
5	.63	.11
6	.56	-.01
7	.68	.15
8	.60	.19
9	.21	.05
10	.04	.02
11	.13	.13
12	.00	.03
197401	-.00	.02
2	.01	.02
3	.15	.02
4	.28	-.03
5	.89	.37
6	.64	.07
7	.52	-.02
8	.54	.12
9	.25	.09
10	.10	.07
11	-.01	.00
12	-.06	-.03
197501	-.05	-.02
2	.06	.07
3	.20	.06
4	.43	.12
5	.59	.07
6	.75	.19
7	.69	.15
8	.47	.06
9	.28	.12
10	.11	.08
11	-.00	.00
12	-.05	-.02
197601	-.10	-.08
2	.03	.04
3	.17	.04
4	.26	-.05
5	.59	.07
6	.37	-.19
7	.56	.02
8	.27	-.15
9	.19	.03
10	.04	.01
11	-.04	-.03
12	-.06	-.02



NOAA-NMFS, PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

EAST COMP. WIND STRESS BY MONTH

MONTH	VALUE	ANOMALY
197701	-.02	.00
2	.00	.01
3	.23	.10
4	.31	.00
5	.36	-.15
6	.64	.07
7	.63	.09
8	.46	.05
9	.27	.11
10	.10	.07
11	-.03	-.02
12	-.03	.00
197801	.00	.03
2	.02	.03
3	.02	-.11
4	.21	-.10
5	.28	-.24
6	.55	-.02
7	.63	.09
8	.47	.06
9	.08	-.08
10	.08	.06
11	0.00	.01
12	-.12	-.08

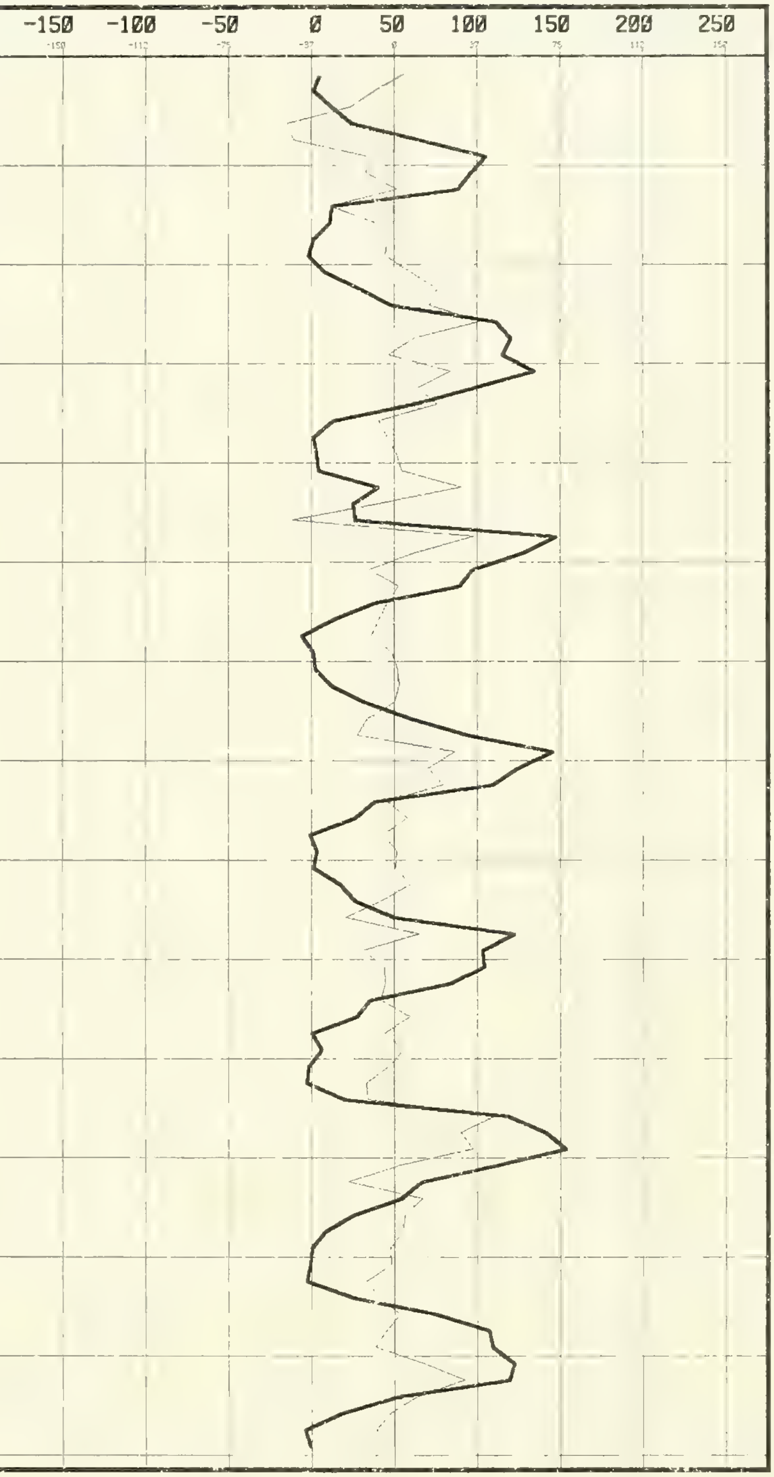


NOAA-NMFS.PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

EKMAN TSPT

BY MONTH

MONTH	VALUE	ANOMALY
196301	5.00	4.56
2	1.00	-8.63
3	12.00	-19.94
4	24.00	-48.25
5	65.00	-45.81
6	105.00	-12.44
7	96.00	-12.63
8	88.00	1.00
9	12.00	-29.31
10	11.00	-9.00
11	1.00	-3.31
12	-2.00	-4.00
196401	8.00	7.56
2	29.00	19.38
3	48.00	16.06
4	111.00	38.75
5	120.00	9.19
6	115.00	-2.44
7	134.00	25.38
8	98.00	11.00
9	61.00	19.69
10	13.00	-7.00
11	1.00	-3.31
12	3.00	1.00
196501	4.00	3.56
2	40.00	30.38
3	25.00	-6.94
4	26.00	-46.25
5	147.00	36.19
6	127.00	9.56
7	97.00	-11.63
8	89.00	2.00
9	38.00	-3.31
10	13.00	-7.00
11	-6.00	-10.31
12	1.00	-1.00
196601	2.00	1.56
2	12.00	2.38
3	32.00	.06
4	60.00	-12.25
5	94.00	-16.81
6	145.00	27.56
7	124.00	15.38
8	109.00	22.00
9	38.00	-3.31
10	26.00	6.00
11	-1.00	-5.31
12	3.00	1.00
196701	1.00	.56
2	17.00	7.38
3	26.00	-5.94
4	50.00	-22.25
5	122.00	11.19
6	103.00	-14.44
7	104.00	-4.63
8	83.00	-4.00
9	35.00	-6.31
10	27.00	7.00
11	0.00	-4.31
12	6.00	4.00
196801	-2.00	-2.44
2	-3.00	-12.63
3	20.00	-11.94
4	118.00	45.75
5	141.00	30.19
6	153.00	35.56
7	111.00	2.38
8	66.00	-21.00
9	54.00	12.69
10	25.00	5.00
11	8.00	3.69
12	0.00	-2.00
196901	-1.00	-1.44
2	-3.00	-12.63
3	25.00	-6.94
4	75.00	2.75
5	107.00	-3.81
6	109.00	-8.44
7	122.00	13.38
8	119.00	32.00
9	52.00	10.69
10	18.00	-2.00
11	-4.00	-8.31
12	-1.00	-3.00

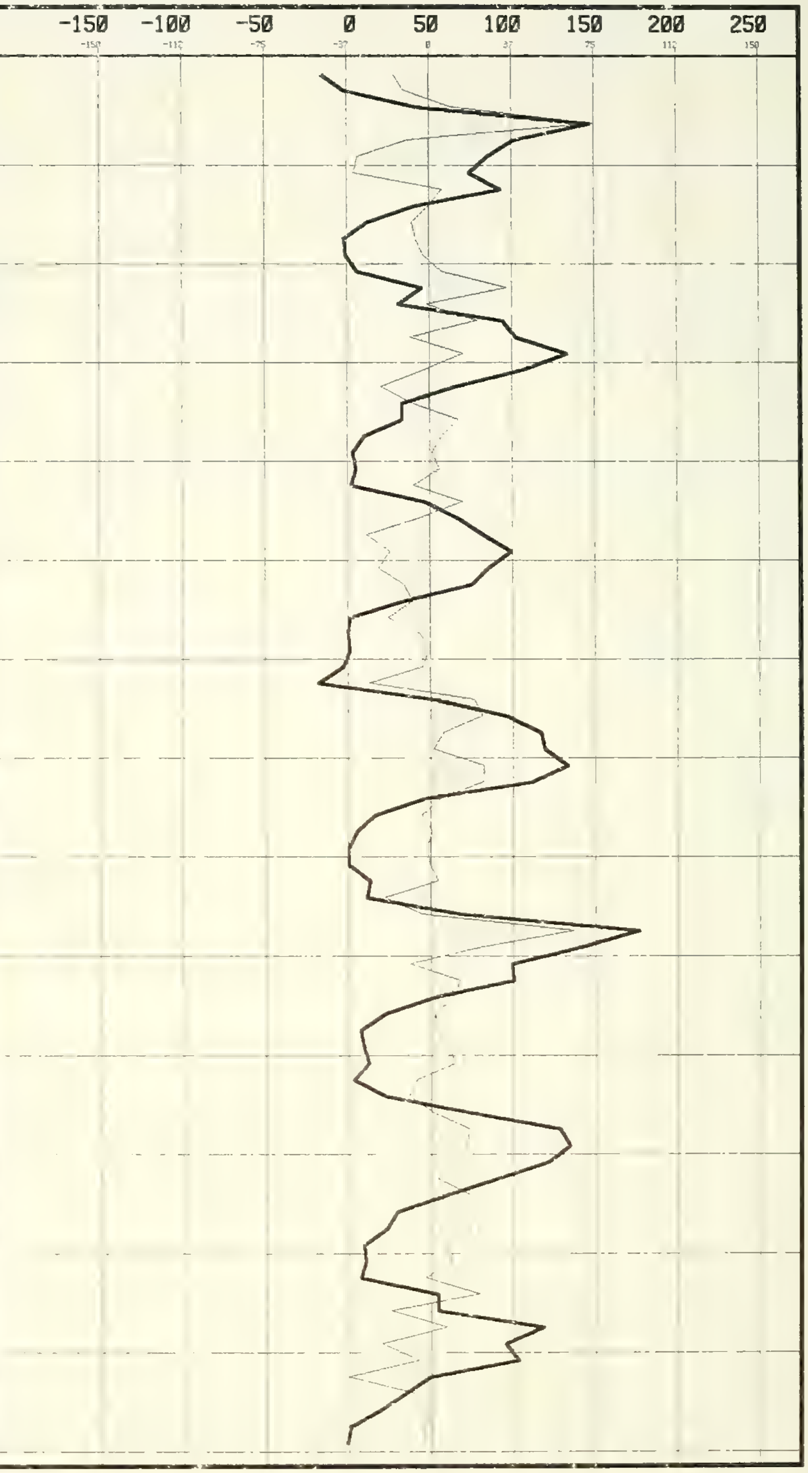


NOAA-NMFS.PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

EKMAN TSPT

BY MONTH

MONTH	VALUE	ANOMALY
197001	-16.00	-16.44
2	-2.00	-11.63
3	42.00	10.06
4	147.00	74.75
5	101.00	-9.81
6	85.00	-32.44
7	74.00	-34.63
8	93.00	6.00
9	41.00	-.31
10	12.00	-8.00
11	-2.00	-6.31
12	-1.00	-3.00
197101	6.00	5.56
2	45.00	35.38
3	31.00	-.94
4	94.00	21.75
5	102.00	-8.81
6	133.00	15.56
7	106.00	-2.63
8	65.00	-22.00
9	33.00	-8.31
10	33.00	13.00
11	10.00	5.69
12	3.00	1.00
197201	5.00	4.56
2	2.00	-7.63
3	47.00	15.06
4	67.00	-5.25
5	82.00	-28.81
6	99.00	-18.44
7	85.00	-23.63
8	75.00	-12.00
9	33.00	-8.31
10	1.00	-19.00
11	0.00	-4.31
12	1.00	-1.00
197301	-3.00	-3.44
2	-18.00	-27.63
3	52.00	20.06
4	96.00	23.75
5	117.00	6.19
6	119.00	1.56
7	133.00	24.38
8	111.00	24.00
9	46.00	4.69
10	16.00	-4.00
11	5.00	.69
12	0.00	-2.00
197401	0.00	-.44
2	13.00	3.38
3	11.00	-20.94
4	68.00	-4.25
5	176.00	65.19
6	141.00	23.56
7	99.00	-9.63
8	100.00	13.00
9	52.00	10.69
10	22.00	2.00
11	7.00	2.69
12	9.00	7.00
197501	12.00	11.56
2	3.00	-6.63
3	22.00	-9.94
4	73.00	.75
5	128.00	17.19
6	134.00	16.56
7	121.00	12.33
8	90.00	3.00
9	59.00	17.69
10	29.00	9.00
11	23.00	18.69
12	9.00	7.00
197601	10.00	9.56
2	7.00	-2.63
3	54.00	22.06
4	54.00	-18.25
5	118.00	7.19
6	95.00	-22.44
7	103.00	-5.63
8	49.00	-38.00
9	34.00	-7.31
10	19.00	-1.00
11	1.00	-3.31
12	-1.00	-3.00

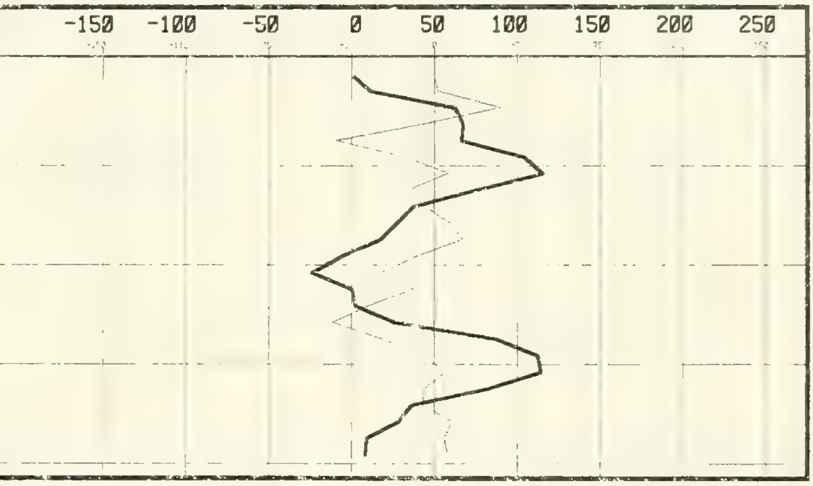


NOAA-NMFS.PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

EKMAN TSPT

BY MONTH

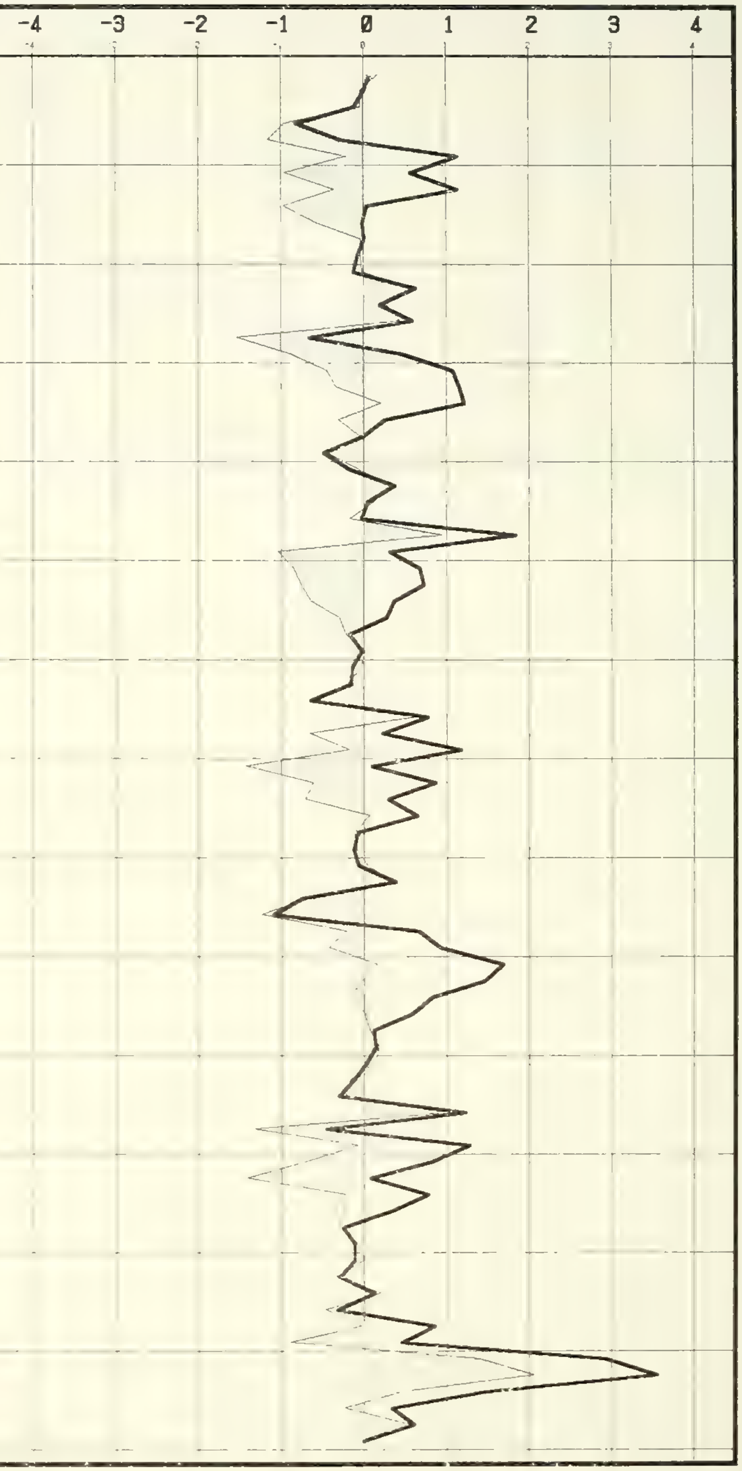
MONTH	VALUE	ANOMALY
197701	0.00	-.44
2	11.00	1.38
3	62.00	30.06
4	67.00	-5.25
5	66.00	-44.81
6	104.00	-13.44
7	115.00	6.38
8	75.00	-12.00
9	37.00	-4.31
10	27.00	7.00
11	17.00	12.69
12	-6.00	-8.00
197801	-24.00	-21.44
2	0.00	-9.63
3	2.00	-29.94
4	26.00	-46.25
5	87.00	-23.81
6	112.00	-5.44
7	114.00	5.38
8	82.00	-5.00
9	36.00	-5.31
10	28.00	8.00
11	9.00	4.69
12	8.00	6.00



NOAA-NMFS.PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

SVERDRUP TRANSPORT BY MONTH

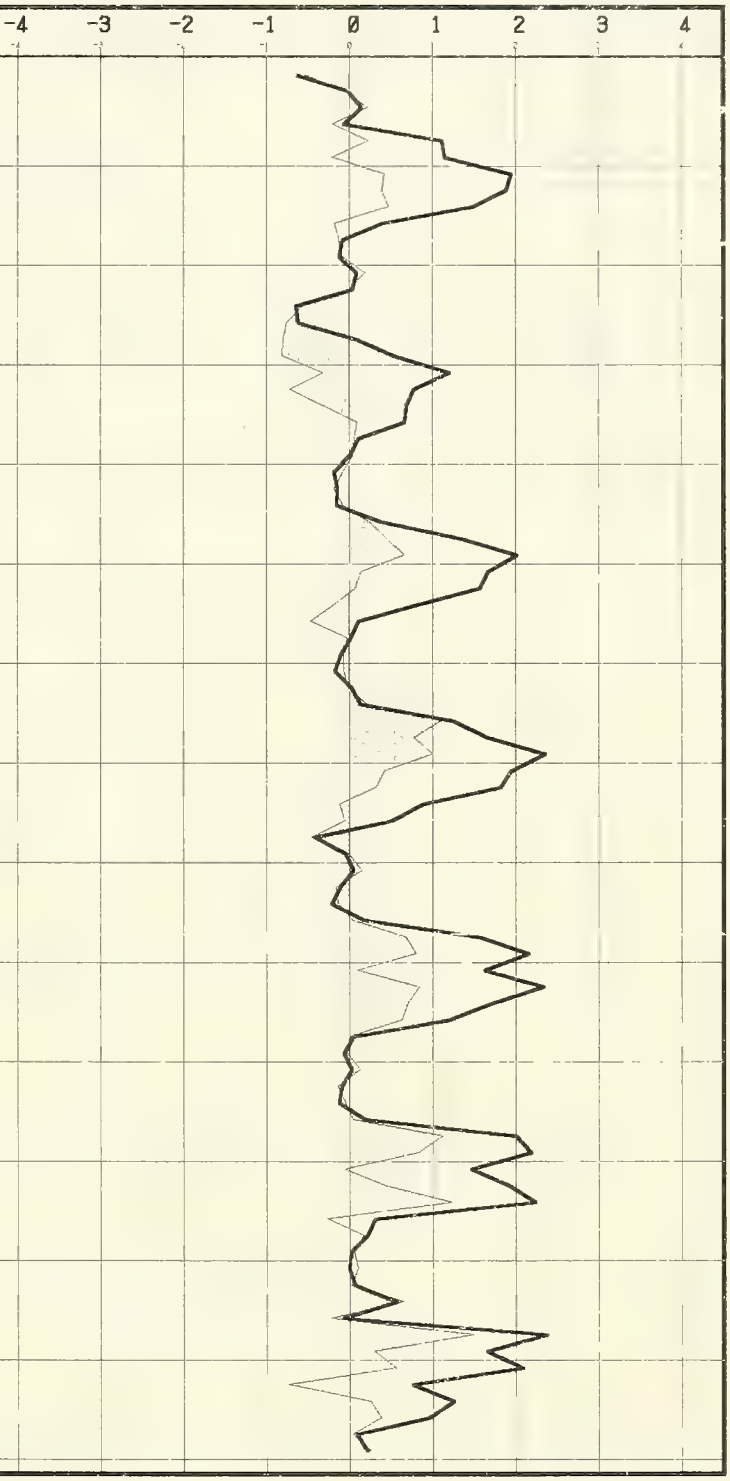
MONTH	VALUE	ANOMALY
196301	.07	.19
2	0.00	-.04
3	-.12	-.04
4	-.82	-.96
5	-.28	-1.16
6	1.13	-.22
7	.56	-.96
8	1.13	-.35
9	.03	-.97
10	-.02	-.59
11	0.00	-.04
12	-.08	-.04
196401	-.13	-.02
2	.62	.58
3	.19	.27
4	.58	.44
5	-.66	-1.54
6	.46	-.89
7	1.07	-.45
8	1.15	-.33
9	1.21	.21
10	.25	-.32
11	-.01	-.05
12	-.49	-.45
196501	-.18	-.07
2	.37	.33
3	.04	.12
4	-.03	-.17
5	1.83	.95
6	.31	-1.04
7	.67	-.85
8	.72	-.76
9	.36	-.64
10	.27	-.30
11	-.18	-.22
12	-.03	.01
196601	-.15	-.04
2	-.16	-.20
3	-.65	-.57
4	.77	.63
5	.22	-.66
6	1.17	-.18
7	.09	-1.43
8	.86	-.62
9	.29	-.71
10	.64	.08
11	-.08	-.12
12	-.13	-.09
196701	-.07	.04
2	.38	.34
3	-.75	-.67
4	-1.10	-1.24
5	.66	-.22
6	.92	-.43
7	1.68	.16
8	1.46	-.02
9	.82	-.18
10	.58	.02
11	.11	.07
12	.14	.18
196801	.02	.14
2	-.13	-.17
3	-.31	-.23
4	1.22	1.08
5	-.46	-1.34
6	1.27	-.08
7	.81	-.71
8	.07	-1.42
9	.77	-.23
10	.33	-.24
11	-.26	-.30
12	-.12	-.08
196901	-.12	-.01
2	-.30	-.34
3	.12	.20
4	-.33	-.47
5	.85	-.23
6	.45	-.90
7	2.92	1.40
8	3.55	2.07
9	1.48	.48
10	.33	-.24
11	.60	.56
12	-.01	.03



NOAA-NMFS, PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

SVERDRUP TRANSPORT BY MONTH

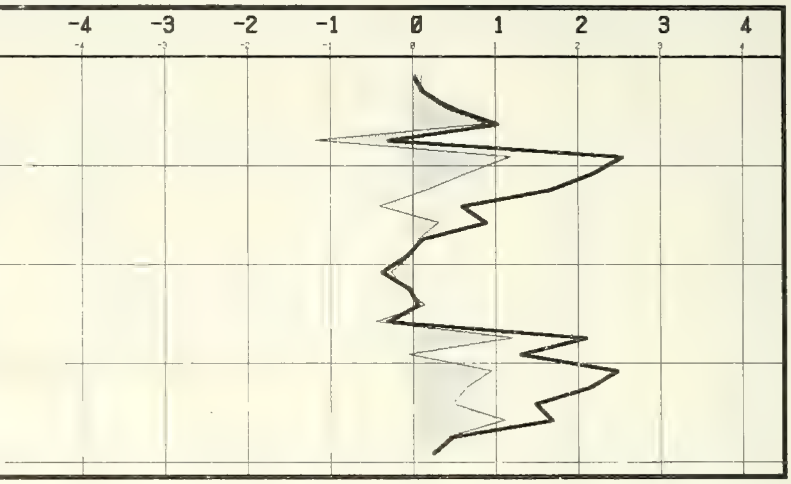
MONTH	VALUE	ANOMALY
197001	-.66	-.55
2	-.02	-.06
3	.14	.22
4	-.07	-.21
5	1.11	.23
6	1.14	-.21
7	1.94	.42
8	1.88	.40
9	1.47	.47
10	.39	-.18
11	-.09	-.13
12	-.13	-.09
197101	.08	.20
2	.03	-.01
3	-.65	-.57
4	-.62	-.76
5	.08	-.80
6	.54	-.81
7	1.20	-.32
8	.77	-.71
9	.68	-.32
10	.66	.10
11	.10	.06
12	0.00	.04
197201	-.19	-.08
2	-.15	-.19
3	-.16	-.08
4	.38	.24
5	1.33	.45
6	2.01	.66
7	1.66	.14
8	1.56	.08
9	.81	-.19
10	.10	-.47
11	.01	-.03
12	-.11	-.07
197301	-.18	-.07
2	.02	-.02
3	.13	.21
4	1.24	1.10
5	1.66	.78
6	2.35	1.00
7	1.94	.42
8	1.81	.33
9	.88	-.12
10	.51	-.05
11	-.42	-.46
12	-.05	-.01
197401	.04	.16
2	-.12	-.16
3	-.22	-.14
4	.18	.04
5	1.56	.68
6	2.15	.80
7	1.62	.10
8	2.33	.85
9	1.70	.70
10	1.19	.63
11	.04	-.00
12	-.07	-.03
197501	.02	.14
2	-.10	-.14
3	-.13	-.05
4	.18	.04
5	2.00	1.12
6	2.18	.83
7	1.46	-.06
8	1.92	.44
9	2.23	1.23
10	.30	-.27
11	.21	.17
12	.01	.05
197601	-.01	-.11
2	.06	.02
3	.56	.64
4	-.08	-.22
5	2.37	1.49
6	1.65	.30
7	2.08	.56
8	.75	-.73
9	1.25	.25
10	.95	.39
11	.08	.04
12	.21	.25



NOAA-NMFS.PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

SVERDRUP TRANSPORT BY MONTH

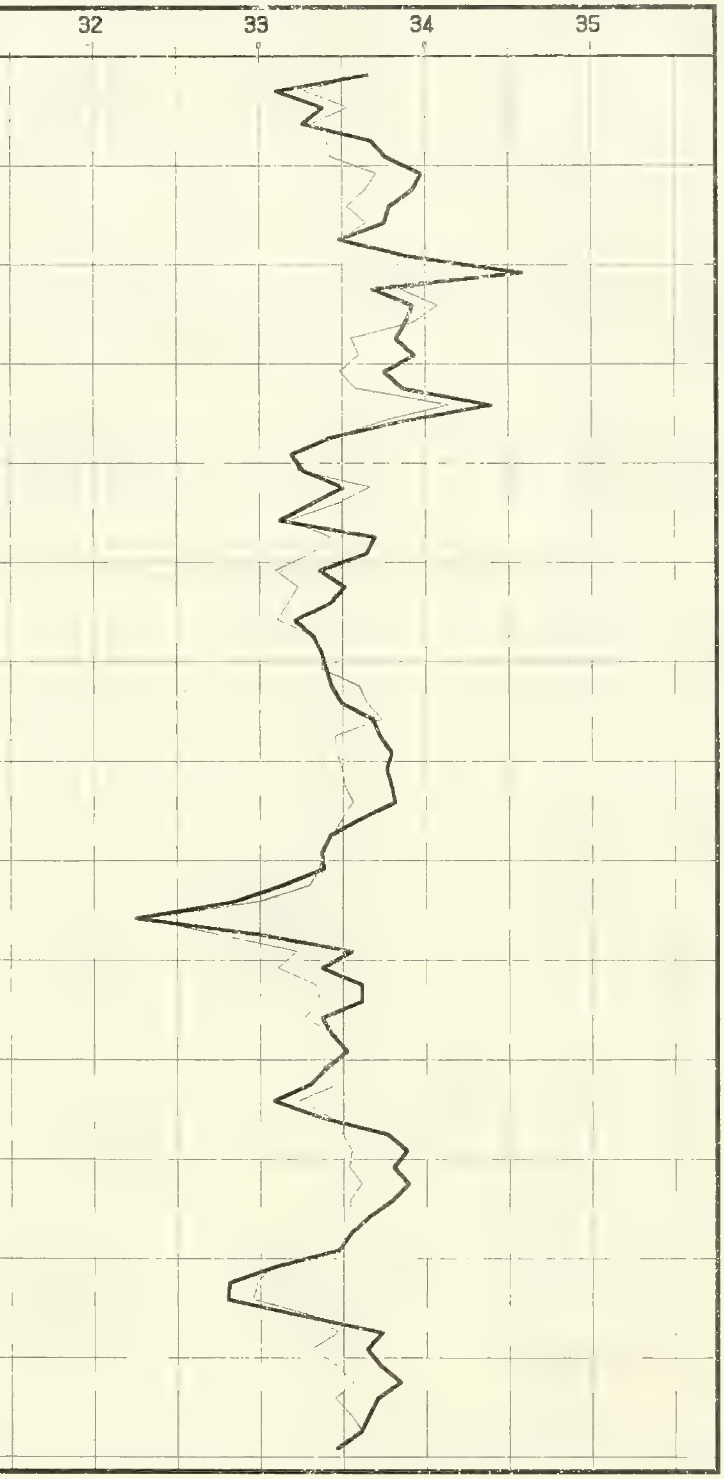
MONTH	VALUE	ANOMALY
197701	0.00	.12
2	.12	.08
3	.43	.51
4	1.02	.88
5	-.30	-1.18
6	2.53	1.18
7	2.18	.66
8	1.66	.18
9	.59	-.41
10	.88	.32
11	.11	.07
12	-.08	-.04
197801	-.38	-.27
2	-.05	-.09
3	.06	.14
4	-.31	-.45
5	2.09	1.21
6	1.30	-.05
7	2.47	.95
8	2.14	.66
9	1.48	.48
10	1.68	1.12
11	.47	.43
12	.24	.28



NOAA-NMFS, PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

SALINITY PACIFIC GROVE, CA BY MONTH

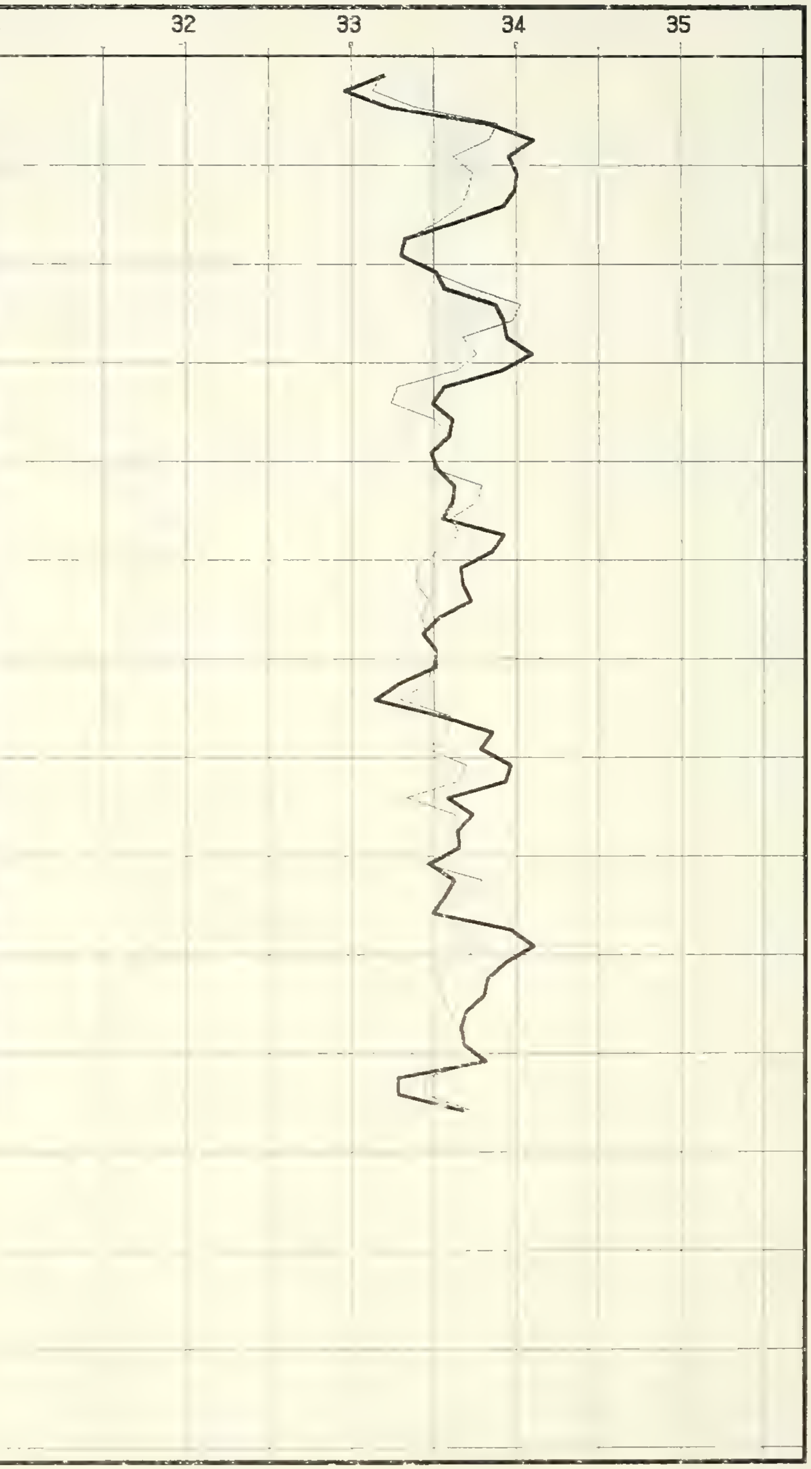
MONTH	VALUE	ANOMALY
196301	33.67	.15
2	33.10	-.23
3	33.38	.03
4	33.26	-.19
5	33.67	-.09
6	33.76	-.07
7	33.97	.20
8	33.92	.14
9	33.78	.03
10	33.75	.14
11	33.48	-.01
12	33.89	.40
196401	34.58	1.06
2	33.68	.35
3	33.92	.57
4	33.88	.43
5	33.82	.06
6	33.93	.10
7	33.75	-.02
8	33.86	.08
9	34.39	.64
10	33.85	.24
11	33.42	-.07
12	33.19	-.30
196501	33.26	-.26
2	33.50	.17
3	33.31	-.04
4	33.12	-.33
5	33.69	-.07
6	33.64	-.19
7	33.36	-.41
8	33.51	-.27
9	33.42	-.33
10	33.21	-.40
11	33.32	-.17
12	33.37	-.12
196601	33.40	-.12
2	33.43	.10
3	33.49	.14
4	33.68	.23
5	33.72	-.04
6	33.79	-.04
7	33.76	-.01
8	33.79	.01
9	33.81	.06
10	33.60	-.01
11	33.42	-.07
12	33.37	-.12
196701	33.38	-.14
2	33.13	-.20
3	32.84	-.51
4	32.25	-1.20
5	33.01	-.75
6	33.55	-.28
7	33.37	-.40
8	33.61	-.17
9	33.61	-.14
10	33.37	-.24
11	33.43	-.06
12	33.52	.03
196801	33.40	-.12
2	33.30	-.03
3	33.08	-.27
4	33.36	-.09
5	33.76	-.00
6	33.88	.05
7	33.80	.03
8	33.89	.11
9	33.79	.04
10	33.65	.04
11	33.54	.05
12	33.47	-.02
196901	33.09	-.43
2	32.81	-.52
3	32.80	-.55
4	33.26	-.19
5	33.73	-.03
6	33.64	-.19
7	33.72	-.05
8	33.84	.06
9	33.70	-.05
10	33.65	.04
11	33.60	.11
12	33.46	-.03



NOAA-NMFS. PACIFIC ENVIRONMENTAL GROUP. MONTEREY. CALIFORNIA

SALINITY PACIFIC GROVE, CA BY MONTH

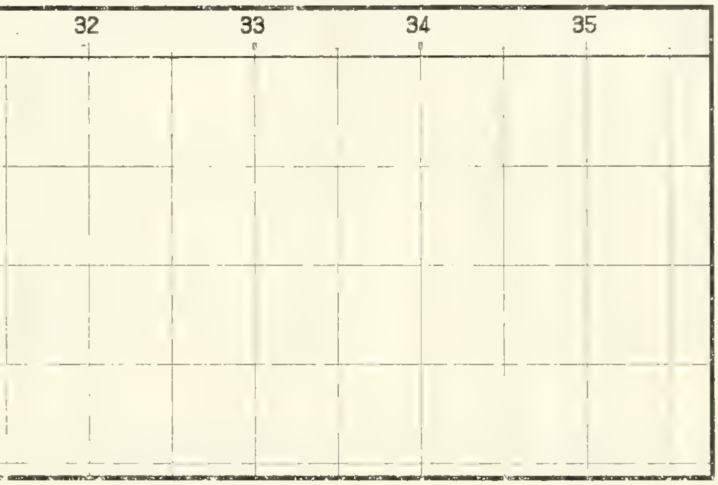
MONTH	VALUE	ANOMALY
197001	33.21	-.31
2	32.96	-.37
3	33.23	-.12
4	33.83	.38
5	34.10	.34
6	33.95	.12
7	34.00	.23
8	33.99	.21
9	33.92	.17
10	33.63	.02
11	33.32	-.17
12	33.30	-.19
197101	33.51	-.01
2	33.56	.23
3	33.87	.52
4	33.92	.47
5	33.94	.18
6	34.09	.26
7	33.91	.14
8	33.56	-.22
9	33.49	-.26
10	33.61	.00
11	33.59	.10
12	33.48	-.01
197201	33.52	-.00
2	33.62	.29
3	33.61	.20
4	33.55	.10
5	33.92	.16
6	33.85	.02
7	33.66	-.11
8	33.67	-.11
9	33.72	-.03
10	33.53	-.08
11	33.43	-.06
12	33.51	.02
197301	33.51	-.01
2	33.29	-.04
3	33.14	-.21
4	33.54	.09
5	33.65	.09
6	33.78	-.05
7	33.96	.19
8	33.93	.15
9	33.73	-.17
10	33.73	.12
11	33.64	.15
12	33.65	.16
197401	33.47	-.05
2	33.62	.29
3	33.56	.21
4	33.43	.04
5	33.96	.20
6	34.10	.27
7	33.93	.16
8	33.82	.04
9	33.80	.05
10	33.69	.08
11	33.65	.17
12	33.68	.19
197501	33.81	[illegible]
2	33.28	-.05
3	[illegible]	-.07
4	[illegible]	.22
5	NO DATA	
6	NO DATA	
7	NO DATA	
8	NO DATA	
9	NO DATA	
10	NO DATA	
11	NO DATA	
12	NO DATA	
197601	NO DATA	
2	NO DATA	
3	NO DATA	
4	NO DATA	
5	NO DATA	
6	NO DATA	
7	NO DATA	
8	NO DATA	
9	NO DATA	
10	NO DATA	
11	NO DATA	
12	NO DATA	



NOAA-NMFS,PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

SALINITY PACIFIC GROVE, CA BY MONTH

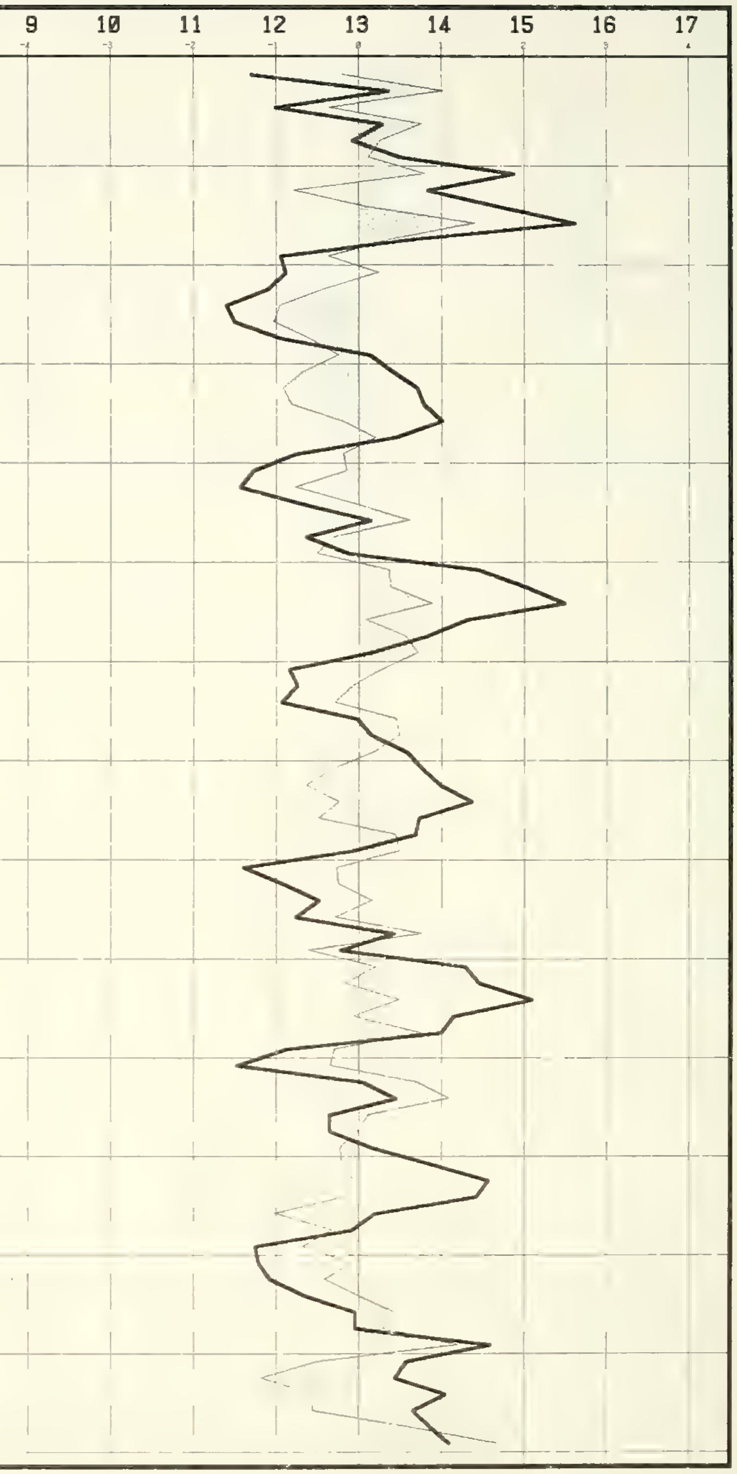
MONTH	VALUE	ANOMALY
197701	NO DATA	
2	NO DATA	
3	NO DATA	
4	NO DATA	
5	NO DATA	
6	NO DATA	
7	NO DATA	
8	NO DATA	
9	NO DATA	
10	NO DATA	
11	NO DATA	
12	NO DATA	
197601	NO DATA	
2	NO DATA	
3	NO DATA	
4	NO DATA	
5	NO DATA	
6	NO DATA	
7	NO DATA	
8	NO DATA	
9	NO DATA	
10	NO DATA	
11	NO DATA	
12	NO DATA	



NOAA-NMFS, PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

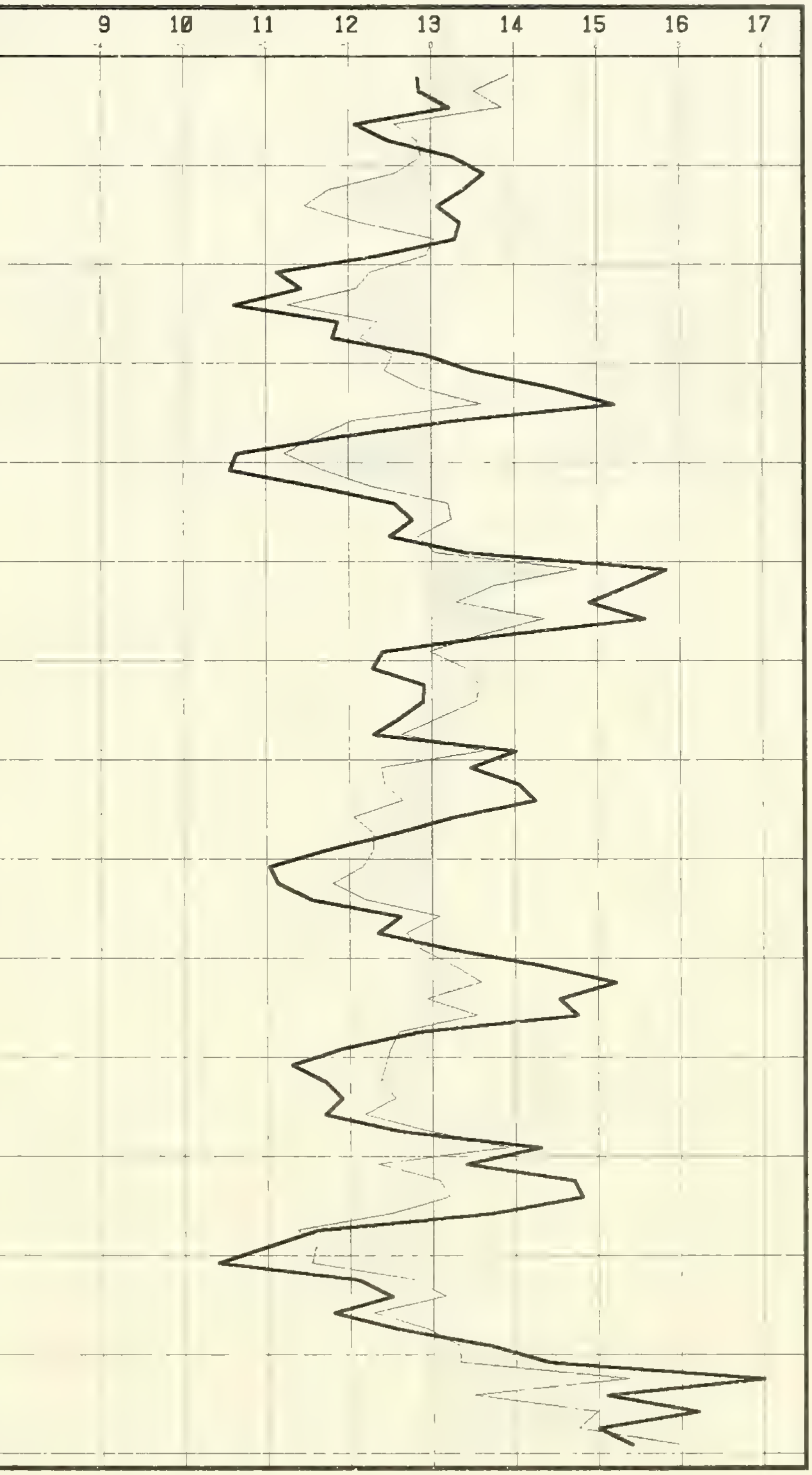
SST PACIFIC GROVE, CA BY MONTH

MONTH	VALUE	ANOMALY
196301	11.66	-.21
2	13.35	1.02
3	11.99	-.36
4	13.28	.76
5	12.92	.26
6	13.50	.12
7	14.87	.80
8	13.83	-.79
9	14.70	.10
10	15.61	1.40
11	13.61	.37
12	12.05	-.37
196401	12.11	.24
2	11.90	-.43
3	11.39	-.96
4	11.49	-1.03
5	12.06	-.60
6	13.13	-.25
7	13.40	-.67
8	13.70	-.92
9	13.78	-.82
10	14.00	-.21
11	13.44	.20
12	12.23	-.19
196501	11.72	-.15
2	11.56	-.77
3	12.30	-.05
4	13.13	.61
5	12.36	-.30
6	12.87	-.51
7	14.44	.37
8	15.00	.38
9	15.48	.88
10	14.30	.09
11	13.81	.57
12	13.13	.71
196601	12.15	.28
2	12.25	-.08
3	12.06	-.29
4	12.97	.45
5	13.15	.49
6	13.57	.19
7	13.76	-.31
8	13.98	-.64
9	14.36	-.24
10	13.72	-.49
11	13.68	.44
12	12.91	.49
196701	11.60	-.27
2	12.08	-.25
3	12.51	.16
4	12.23	-.29
5	13.42	.76
6	12.77	-.61
7	14.28	.21
8	14.45	-.17
9	15.09	.49
10	14.14	-.07
11	13.99	.75
12	12.12	-.30
196801	11.52	-.35
2	13.03	.70
3	13.44	1.09
4	12.64	.12
5	12.64	-.02
6	13.15	-.23
7	13.86	-.21
8	14.56	-.06
9	14.41	-.19
10	13.19	-1.02
11	12.91	-.33
12	11.74	-.66
196901	11.78	-.09
2	11.92	-.41
3	12.34	-.01
4	12.95	.43
5	12.95	.29
6	14.58	1.20
7	13.57	-.50
8	13.43	-1.19
9	14.04	-.56
10	13.65	-.56
11	13.86	.62
12	14.09	1.67



SST PACIFIC GROVE, CA BY MONTH

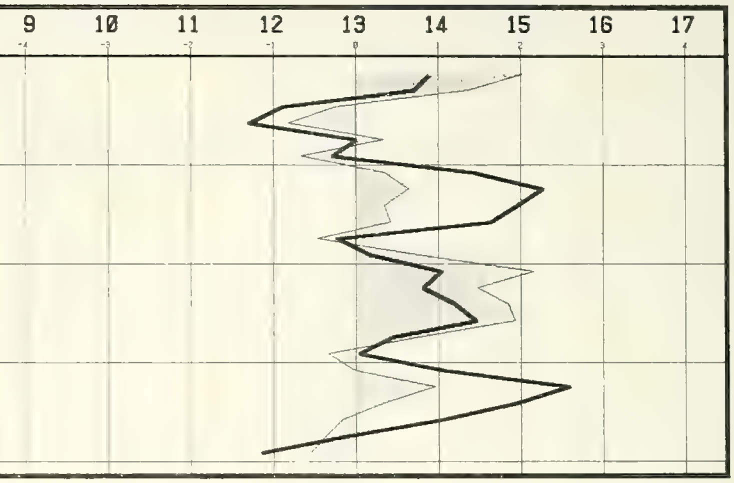
MONTH	VALUE	ANOMALY
197001	12.83	.96
2	12.85	.52
3	13.21	.86
4	12.07	-.45
5	12.48	-.18
6	13.26	-.12
7	13.63	-.44
8	13.38	-1.24
9	13.07	-1.53
10	13.34	-.87
11	13.28	.04
12	12.35	-.07
197101	11.13	-.74
2	11.42	-.91
3	10.61	-1.74
4	11.86	-.66
5	11.80	-.86
6	12.91	-.47
7	13.50	-.57
8	14.46	-.16
9	15.20	.60
10	13.26	-.95
11	11.83	-1.41
12	10.64	-1.78
197201	10.56	-1.31
2	11.61	-.72
3	12.55	.20
4	12.76	.24
5	12.49	-.17
6	13.42	.04
7	15.83	1.76
8	15.38	.76
9	14.90	.30
10	15.57	1.36
11	13.83	.59
12	12.40	-.02
197301	12.28	.41
2	12.90	.57
3	12.89	.54
4	12.61	.09
5	12.29	-.37
6	14.01	.63
7	13.46	-.61
8	14.04	-.58
9	14.24	-.36
10	13.26	-.95
11	12.53	-.71
12	11.71	-.71
197401	11.03	-.84
2	11.13	-1.20
3	11.55	-.80
4	12.61	.09
5	12.34	-.32
6	13.24	-.14
7	14.34	.27
8	15.21	.59
9	14.53	-.07
10	14.75	.54
11	12.83	-.41
12	11.91	-.51
197501	11.30	-.57
2	11.70	-.63
3	11.90	-.45
4	11.70	-.82
5	12.60	-.06
6	14.30	.92
7	13.40	-.67
8	14.70	.08
9	14.80	.20
10	13.70	-.51
11	11.60	-1.64
12	11.00	-1.42
197601	10.40	-1.47
2	12.10	-.23
3	12.50	.15
4	11.80	-.72
5	12.60	-.06
6	13.70	.32
7	14.40	.33
8	17.00	2.38
9	15.10	.50
10	16.20	1.99
11	15.00	1.76
12	15.40	2.98



NOAA-NMFS.PACIFIC ENVIRONMENTAL GROUP. MONTEREY. CALIFORNIA

SST PACIFIC GROVE, CA BY MONTH

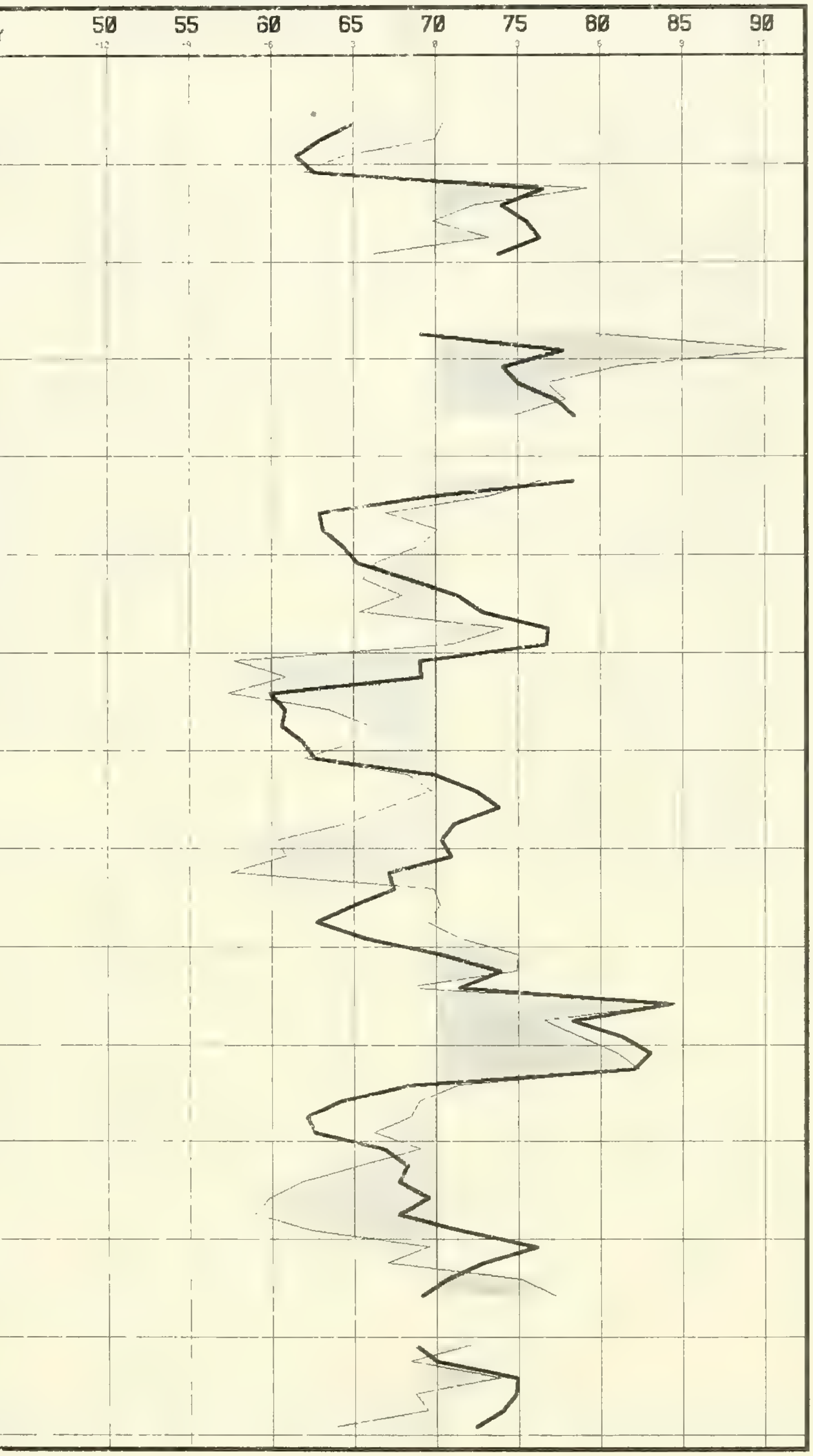
MONTH	VALUE	ANOMALY
197701	13.90	2.03
2	13.70	1.37
3	12.10	-.25
4	11.70	-.82
5	13.00	.34
6	12.71	-.67
7	14.42	.35
8	15.26	.64
9	14.95	.35
10	14.63	.42
11	12.77	-.47
12	13.18	.76
197801	14.03	2.16
2	13.81	1.48
3	14.20	1.85
4	14.45	1.93
5	13.43	.77
6	13.04	-.34
7	14.04	-.03
8	15.58	.96
9	14.94	.34
10	14.04	-.17
11	12.87	-.37
12	11.86	-.56



NOAA-NMFS.PACIFIC ENVIRONMENTAL GROUP, MONTEREY, CALIFORNIA

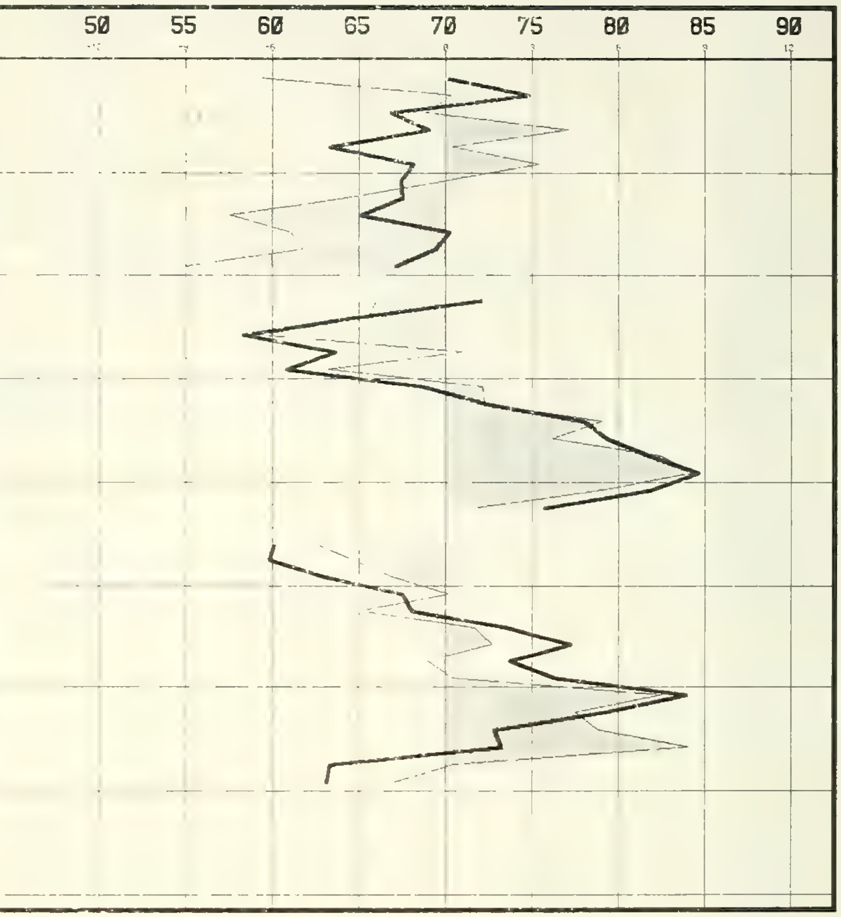
CM DYNAMIC HEIGHT BY MONTH

MONTH	VALUE	ANOMALY
196801	NO DATA	
196802	NO DATA	
196803	NO DATA	
196804	65.00	.26
196805	63.00	-.04
196806	61.50	-3.37
196807	62.60	-4.80
196808	76.50	5.54
196809	74.00	1.43
196810	75.50	-.08
196811	76.30	1.96
196812	73.80	-2.26
196901	NO DATA	
196902	NO DATA	
196903	NO DATA	
196904	NO DATA	
196905	68.90	5.86
196906	77.70	12.83
196907	74.10	6.70
196908	75.00	4.04
196909	77.30	4.73
196910	78.40	2.82
196911	NO DATA	
196912	86.60	10.54
197001	NO DATA	
197002	78.52	3.91
197003	69.40	1.90
197004	62.90	-1.84
197005	63.10	.06
197006	64.30	-.57
197007	65.20	-2.20
197008	68.30	-2.66
197009	71.30	-1.27
197010	72.80	-2.78
197011	76.60	2.46
197012	76.70	.64
197101	69.00	-7.39
197102	69.10	-5.49
197103	59.90	-7.60
197104	60.80	-3.94
197105	60.60	-2.44
197106	61.90	-2.97
197107	62.60	-4.80
197108	69.90	-1.05
197109	72.40	-.17
197110	73.50	-1.78
197111	71.10	-3.24
197112	70.30	-5.76
197201	70.90	-5.49
197202	67.10	-7.49
197203	67.40	-.10
197204	64.90	.16
197205	62.70	-.34
197206	65.70	.83
197207	70.40	3.00
197208	73.90	2.94
197209	71.40	-1.17
197210	84.30	8.72
197211	78.30	3.95
197212	81.30	5.24
197301	83.00	6.61
197302	82.00	7.41
197303	68.30	.85
197304	64.10	-.64
197305	62.10	-.94
197306	62.60	-2.27
197307	66.80	-.62
197308	68.20	-2.76
197309	67.70	-4.87
197310	69.50	-6.08
197311	67.70	-6.64
197312	71.50	-4.53
197401	76.10	-.29
197402	72.80	-1.79
197403	70.60	3.10
197404	69.10	4.36
197405	NO DATA	
197406	NO DATA	
197407	68.70	1.30
197408	70.00	-.96
197409	74.90	2.33
197410	74.80	-.78
197411	74.00	-.34
197412	72.40	-3.66



CM DYNAMIC HEIGHT BY MONTH

MONTH	VALUE	ANOMALY
197501	70.00	-6.39
197502	74.80	.21
197503	66.80	-.70
197504	69.00	4.26
197505	63.30	.26
197506	68.10	3.23
197507	67.40	.00
197508	67.50	-3.46
197509	65.10	-7.47
197510	70.20	-5.38
197511	69.40	-4.94
197512	67.10	-8.96
197601	NO DATA	
197602	72.20	-2.39
197603	64.80	-2.70
197604	58.30	-6.44
197605	63.60	.56
197606	60.80	-4.07
197607	68.70	1.30
197608	72.30	1.34
197609	78.00	5.43
197610	79.30	3.72
197611	81.80	7.46
197612	84.60	8.54
197701	81.80	5.41
197702	75.70	1.11
197703	NO DATA	
197704	60.10	-4.64
197705	59.80	-3.24
197706	63.00	-1.87
197707	67.50	.13
197708	68.00	-2.96
197709	73.60	1.03
197710	77.20	1.62
197711	73.70	-.64
197712	76.30	.24
197801	83.90	7.51
197802	79.10	4.51
197803	72.80	5.30
197804	73.20	8.46
197805	63.30	.73
197806	63.10	-1.[illegible]
197807	NO DATA	
197808	NO DATA	
197809	NO DATA	
197810	NO DATA	
197811	NO DATA	
197812	NO DATA	



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NMFS Circular and Special Scientific Report—Fisheries

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Abundance of Pelagic Resources Off California, 1963-78, as Measured by an Airborne Fish Monitoring Program

James L. Squire, Jr.

February 1983

U.S. DEPARTMENT OF COMMERCE
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National Oceanic and Atmospheric Administration
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Abundance of Pelagic Resources Off California 1963-78, as Measured by an Airborne Fish Monitoring Program

JAMES L. SQUIRE, JR.

ABSTRACT

From September 1962 through December 1978 commercial aerial fish-spotter pilots operating off southern and central California and northern Mexico, maintained a flight log indicating the geographical areas searched and an estimate of the quantity of pelagic species observed. These flight logs were analyzed for quantities of the various species observed per block area (10′ longitude by 10′ latitude area). Flights were recorded as surveying all or a portion of 164,753 block areas. A total of 110,375 block areas were surveyed during the day and 54,378 during night operations. An annual index of apparent abundance (arbitrary values) was computed for each of the major species observed, both for day and night aerial observations from selected geographical areas, and for total observations. The index value computed is not directly comparable between species.

During the period of the survey, the apparent abundance index for Pacific sardine, *Sardinops sagax caerulea*, declined from 1.03 in 1964 to 0.00 in 1974, and no significant schools have been observed by aerial surveys since. The northern anchovy, *Engraulis mordax*, night apparent abundance index remained relatively constant from 1963 to 1969 (2.99-4.35), increased substantially in 1973 to 14.99, then declined by 1978 to a level (1.91) near that observed in 1963-69. The day index for Pacific bonito, *Sarda chiliensis*, declined to a low level in 1968-69 (0.43-0.26), increased in 1972 to 1.11 (a year of above average sea surface temperature), and in subsequent years declined again to a low level (±0.1). Pacific mackerel, *Scomber japonicus*, population biomass was apparently low in 1962 at the start of the surveys, and continued to decline to very low night abundance levels during 1967-75 (undefined range of 0.00 to 0.03). In 1976 a small increase in the overall apparent index was recorded. By 1977 the night index had increased to 2.62, and in 1978 it again increased to a high level of 7.46. Jack mackerel, *Trachurus symmetricus*, showed a declining abundance index value during 1969-75 (0.66-0.40). A small increase in the night index apparent abundance was noted in 1976, and in 1977 the night index increased to 2.77. In 1978 it then increased about 1.5 times to a record high of 4.20.

Downward trends in apparent abundance indexes were noted 1 to 2 yr in advance of declines in the commercial catches for northern anchovy and Pacific bonito. Limitations of collected nonrandom data and variations in sightings and school size estimation between pilots are discussed. The apparent abundance indexes obtained from aerial surveys are compared with measures from larval and acoustical surveys.

A rank correlation analysis was made to measure the agreement between independent estimates of northern anchovy spawning biomass, larval index, and aerial index. Significant correlations were found for the aerial and acoustical survey indices of 1972-78 for the northern anchovy ($r_s = 0.810$, significant at the 0.05 level). During this period only three larval surveys were conducted, insufficient to calculate correlation. For earlier data, 1962-66 and 1968-69, larval vs. aerial index gave a poor correlation (+0.30). A significant correlation was evident for Pacific mackerel aerial index vs. spawning biomass index ($r_s = 1.00$).

INTRODUCTION

The Southwest Fisheries Center, National Marine Fisheries Service (NMFS), initiated an aerial pelagic fish monitoring program in 1962 with the cooperation of fish-spotter pilots active in locating fish for the central and southern California commercial purse seine fishery. The program utilized the services of the aerial fish-spotter pilot as a spin-off from their major occupation. The objective of the monitoring program was to measure and evaluate the apparent abundance of pelagic near-surface schooling fishes.

It was originally hypothesized that basic sighting data for the various species—tonnage estimates, or numbers of schools and their individual tonnage estimates, compared with search effort—would provide a measure of the relative apparent abundance of each species within a fishing area. Such information would be useful in assessment of the available stocks. Since sighting information from the spotter pilots is used as an aid in fishing, the efficiency of the pilot in locating schools and sometimes directing the setting of the purse seine has affected the catch per effort of the purse seiner. Therefore, aerial spotter data may be more useful than fishing vessel records for detecting changes in abundance of intensively fished species. The aerial fish-spotter also records the abundance of pelagic species which may not currently be targeted upon by the fishery. Aerial survey data, therefore, can be particularly useful in evaluating underutilized pelagic near-surface schooling resources.

The first report on the results of the program (Squire 1972) reviewed trends in apparent abundance for data collected from 1962 through 1969. This review updates these data through 1978 using the same analytical methods. Since publication of the first review, considerable changes in the apparent abundance levels of some pelagic species has occurred. The species of interest to this program are all members of a complex, interacting coastal ecosystem, and these data may assist in better defining changes in abundance levels over time which occur within the coastal pelagic resources complex. For a definition of terms used such as abundance, apparent abundance, and relative apparent abundance, see Marr (1951).

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[1] Southwest Fisheries Center La Jolla Laboratory, National Marine Fisheries Service, NOAA, La Jolla, CA 92038.

The fish species most commonly observed by the commercial fish-spotters while operating off central and southern California, and northern Baja California, Mexico, are the northern anchovy, *Engraulis mordax*; jack mackerel, *Trachurus symmetricus*; Pacific bonito, *Sarda chiliensis*; Pacific mackerel, *Scomber japonicus*; Pacific sardine, *Sardinops sagax caerulea*; and bluefin tuna, *Thunnus thynnus*. Other species such as Pacific barracuda, *Sphyraena argentea*, yellowtail, *Seriola lalandei*, white seabass, *Atractoscion nobilis*, and albacore, *Thunnus alalunga*, are observed by the pilots, and are sometimes caught by the commercial fleet with the aid of aerial spotters. Other animals such as the basking shark, *Cetorhinus maximus*, mammals (whales and porpoise), and invertebrates (squid—*Loligo opalescens*), have been observed and recorded. A total of 20 species of fish have been observed and recorded by the spotter pilots (Squire 1972).

METHODS

Commercial aerial fish-spotters have recorded flight tracks and fish school tonnage estimates for the program since the fall of 1962; 1963, however, was the first complete year of data. The pilots in the program are full-time professional commercial fish-spotter pilots. Participating pilots under contract were advised that all sightings of schooling fish were to be reported. A total of 15 pilots have participated in the program. Observation quality has remained relatively stable since the pilots who have made the major contributions to the program have participated in it throughout its 16-yr period. There has been no attempt to intercalibrate the pilots. The only data gap in the program is for the second half of 1970 (July through December), when contracts for observation data were cancelled.

For a review of the methods and procedures for obtaining and processing the flight log observation data, and for results of the program for the period 1963-69, see Squire (1972). Caruso[2] described by details of computer coding of the aerial observations for future analysis. The general procedure for recording fish sighting observations on flight log charts has not changed from that described by Squire (1972). In 1974 flight log charts were added to cover the northwest coast of Baja California, Mexico. With the addition of charts for the area south of the United States-Mexico border, pilots recorded observation sighting data for summer flights in search of bluefin tuna. The borders of 10′ longitude × 10′ latitude "block areas" and associated "block numbers" were printed on the charts to expedite data coding. The "block areas" referred to are identical to the California Fish and Game statistical grid system. The area from Half Moon Bay, Calif., to Cedros Island, Baja California, Mexico, has six flight log charts. Divisions of this area into "block areas," which were later combined into larger grouped "zones" lettered A through T, are shown in Figure 1.

Pilots recorded their flight paths and school sightings on the appropriate charts. Aerial spotter data was analyzed by using summaries of the number of block areas entered into by the pilots as a measure of observation effort and tonnage estimates of fish.

Approximately 40,000 flight hours of observations were recorded. A total of 164,753 block areas or portions of block areas were surveyed: 110,375 (67%) during the day and 54,378 (33%) during the night (Table 1). A graph of each year's day, night, and total observation effort is given in Figure 2.

From 1962 to 1978, no natural changes in the survey area occurred that could be classed as atypical. However, one unusual event did occur that had a severe local impact and affected the observation of near-surface pelagic species. In late January 1969, a large release of crude oil occurred in the Santa Barbara Channel area. The oil release continued in varying quantities for some months afterward, and affected fishing and aerial fish-spotting operations in the eastern half of the Santa Barbara Channel and around the Channel Islands. Since this was an area where concentrations of anchovy, jack mackerel, and Pacific bonito were previously observed by the aerial spotters and fished by commercial seiners, the oil contamination resulted in a temporary cessation of fishing. During the months when the surface crude oil spill was a problem, however, frequent aerial surveys of the Santa Barbara Channel and Islands area were made by the Union Oil Company, using an aerial spotter pilot who was participating in the NMFS program. Data from these observations were recorded in the same format as the NMFS pelagic fish program and made available to the NMFS for analysis.

Flight log data represent a sample estimate of the apparent abundance of pelagic species schooling in the near-surface layers of the areas surveyed. The selection of flight tracks was nonrandom,

Table 1.—Observation effort off California for pelagic commercial fish (day/night) in units of block area overflights by zone.

Zone	1962-65	1966-69	1970-73	1974-78	Total
A	443/310	1,271/38	14/0	22/0	1,750/348
B	1,148/600	2,025/113	218/48	180/53	3,571/814
C	2,098/2,207	6,020/2,053	10,508/3,151	6,213/3,475	24,839/10,886
D	1,043/1,190	5,023/1,921	5,075/1,503	4,659/3,801	15,800/8,415
E	151/427	336/287	124/122	743/298	1,354/1,134
F	40/181	166/316	123/732	381/472	710/1,701
G	1,329/1,512	3,583/3,206	4,222/3,899	7,974/8,369	17,108/16,986
H	1,041/967	1,829/1,556	1,612/2,001	3,156/2,595	7,638/7,119
I	1,238/510	2,585/1,215	1,178/1,298	3,356/1,026	8,357/4,049
J	1,599/626	3,538/749	4,208/211	5,353/726	14,698/2,312
K	35/0	315/52	932/72	1,796/38	3,078/162
L	0/0	0/0	1,287/47	5,157/202	6,444/249
M	0/0	0/0	22/3	43/0	65/3
N	0/0	0/0	878/0	3,094/165	3,972/165
O	0/0	0/0	0/0	0/0	0/0
P	0/0	0/0	212/0	618/35	830/35
Q	0/0	0/0	0/0	0/0	0/0
R	0/0	0/0	0/0	161/0	161/0
					110,375/54,378

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[2] Caruso, J. 1979. Aerial marine resources monitoring system. Data Coding Manual. Admin. Rep. LJ-79-9, 99 p. Southwest Fisheries Center La Jolla Laboratory, NMFS, NOAA, La Jolla, CA 92038

being determined by past experience regarding the most likely locations for sighting schools of various species, real-time information from fishing boats and other spotter aircraft, and other recent experience. The species identification of the schools was determined during the day by physical characteristics such as shape or color of the fish or school, or by behavior of the fish. During the night, identification was made by the bioluminescent characteristics of the school's shape or its behavioral response to a flash of light. Information from fishing vessels was sometimes used in determining species composition, particularly where "mixed schools" were encountered.

A pilot's estimate of school tonnage is based on many years of observing school size, shape, depth, and quantity as determined by catching the fish observed. It is possible to estimate a school's vertical depth (distance from top of school to bottom) for schools of the larger pelagic species and small schools of such species as the northern anchovy. However, for large schools of the smaller forage species, the actual depth of the school usually cannot be determined from the air. Therefore, information from fishing vessels was frequently used since they could determine the school's vertical depth using an echosounder. The horizontal shape and area of the school could be estimated visually. Aerial spotter pilots are often paid on the basis of tonnage caught, so a close check on tonnage taken by the purse seiner is important to the pilot.

SIGHTINGS AND ABUNDANCE INDEX TRENDS BY SPECIES

Geographical Distribution of Fish School and School Group Sighting

Current and historical records, based on catch or fishing boat logbook data, give some indication of the location of catch, but only by "block area" (a 10′ longitude × 10′ latitude area), which measures about 8 × 10 nmi each at the latitude of southern California. A more detailed description of individual locations of the center of school or school group sightings as observed on each flight (day plus night) for the period 1962 through 1978 is given in Figures 4-61.

An illustration of how the center of sighting was determined is given in Figure 3. The dot on the chart is the geographical center of the sighting, representing one or more animals or schools observed in the area. On some charts having a high density of sightings, an overlap or masking may occur, particularly for anchovy.

Locations of centers of sightings are given for the northern anchovy (Figs. 4-11), Pacific sardine (Figs. 14-18), Pacific bonito (Figs. 20-27), Pacific mackerel (Figs. 30-36), jack mackerel (Figs. 38-45), bluefin tuna (Figs. 47-49), albacore tuna (Figs. 50 and 51), yellowtail (Figs. 52 and 53), Pacific barracuda (Figs. 54 and 55), white seabass (Figs. 56 and 57), basking shark (Figs. 58 and 59), and squid (Figs. 60 and 61).

A review of the sighting distribution charts is given in the following sections for those areas having the most sightings. In many instances the charts for north of Morro Bay and those below the United States-Mexico border are not shown because the observation effort was low, or the effort was not expended in areas where the species of interest would be commonly observed. For example, anchovy charts are not given for the Monterey Bay area because, although anchovies have frequently been observed in the area, the observation effort since the mid-1950's has been low. Most of the flight observation effort south of the United States-Mexico border has been offshore in search of bluefin tuna, and, as a result, nearshore areas commonly having schools of anchovies are rarely surveyed and are therefore not given.

During the survey period, the following total number of sightings of schools or school groups were made: northern anchovy, 8,720; Pacific sardine, 195; Pacific bonito, 3,873; Pacific mackerel, 1,273; jack mackeral, 3,233; bluefin tuna, 1,314; albacore tuna, 200; yellowtail, 94; Pacific barracuda, 138; white seabass, 70; and squid, 384. The observations of schools or school group for the major species observed represent a total tonnage sighted by day and night of 43,013,254 t of northern anchovy; Pacific sardine, 442,644 t; Pacific bonito, 442,644 t; Pacific mackerel 1,364,048 t; jack mackerel 1,869,256 t; and bluefin tuna, 507,366 t.

Apparent Abundance Index Trends

Day and night indices of apparent abundance for each zone and grouped zones have been calculated annually since 1963 for species of northern anchovy, Pacific bonito, jack mackerel, Pacific mackerel, Pacific sardine, Pacific barracuda, and yellowtail. Bluefin tuna indices have been calculated since 1974.

In calculating the index value, one of four arbitrary tonnage ranges for each species was assigned. These cover the range of observed tonnages that might be estimated to occur in any one block area. In order to provide a tonnage range value (*x*) the midpoint of each range was divided by 100 for the northern anchovy, a species that is observed in larger quantities compared with any others and by 10 for Pacific bonito, jack mackerel, Pacific mackerel, Pacific sardine, and bluefin tuna. The midpoint of the tonnage range for yellowtail and white seabass was not reduced. The range of observed tonnage and resulting *x* values are given in Table 2. The

Table 2.—Range of tonnage and tonnage range values (*X*). *X* is the index value based on the midpoint of the observed tonnage/100 (but not for barracuda or yellowtail).

Species	Observed tonnage	*X*
Anchovy	0-400	2
	401-1,000	7
	1,001-10,000	55
	10,001-20,000	150
Pacific bonito	0-50	2.5
	51-150	10
	151-1,000	57.5
	1,001-5,000	300
Jack mackerel	1-50	2.5
	51-300	17.5
	301-1,000	65.5
	1,001-2,000	150
Pacific mackerel	0-20	1
	21-100	6
	101-250	17.6
	251-500	37.5
Pacific sardine	0-100	5
	101-500	30
	501-2,000	125
	2,001-4,000	300
Bluefin tuna	0-50	2.5
	51-250	15
	251-1,000	62.5
	1,001-4,000	250
Pacific barracuda	0-10	5
	11-30	20
	31-80	55
	81-160	120
Yellowtail	0-5	2.5
	6-10	7.5
	11-30	20
	31-60	45

following formula was used to calculate annual indices of apparent abundance, day and night, by zone and by species:

$$\text{Index of apparent abundance} = \frac{\Sigma N_1X_1 + N_2X_2 + N_3X_3 + N_4X_4}{N_t}$$

where $N_{1,2,3,4}$ = number of block area flights in which the species occurred at value $X_{1,2,3,4}$,
$X_{1,2,3,4}$ = tonnage range values,
N_t = total number of block area flights in the zone during the year.

The index value, then, represents the relationship between the amount of fish observed (tonnage range value—x), divided by the amount of search effort (number of block area flights) conducted either during the night or during the day. Day and night indices of apparent abundance for each zone, and the annual average day/night indices of apparent abundance for all zones, are listed in Table 3. The boundaries of the zones were selected to outline important geographical areas where fish were commonly observed.

The index trends reviewed here are for the major commercial species of northern anchovy, Pacific sardine, Pacific bonito, Pacific mackerel, jack mackerel, and bluefin tuna. Apparent abundance trends for yellowtail and Pacific barracuda, species which are primarily targets of the recreational fishery, are given in Table 3 but are not reviewed here. During the survey period, sightings of these species were few, and have been much reduced in recent years, with a resultant decrease in indices.

An analysis of sightings by day or night and of tonnage observed (Squire 1972), indicated that the northern anchovy, Pacific mackerel, jack mackerel, and Pacific sardine were observed more frequently and in greater quantity during the night. Pacific bonito and bluefin tuna were observed in greater quantity in the day. The selection of the index that is most representative of the apparent abundance of each species is based on the 1972 study.

In the following sections, total effort and observations by year are shown in graphic displays of day/night index values and U. S. fishery catch trends during 1963-78 for each species, along with a review of areas of high sighting density during 1962-78.

Northern Anchovy

Morro Bay to San Nicolas Island.—1962-65, Fig. 4; 1966-69, Fig. 5; 1970-73, Fig. 6; and 1974-78, Fig. 7.

The sighting effort north of Pt. Conception was greatly reduced after the 1962-65 period. Anchovy schools were commonly observed off Morro Bay and Avila, the latter area being a location where schools were commonly observed. The Santa Barbara coast from Gaviota eastward, and into the eastern end of the Santa Barbara Channel, had a high level of anchovy sightings, with the major area of sighting located offshore between the cities of Santa Barbara and Ventura. In 1974-78, the center of sighting appeared to be slightly farther offshore between Santa Barbara and Ventura, but in 1978, the center of sighting appeared about equidistant between the two cities and much nearer shore than observed in previous years.

Pt. Hueneme to San Diego.—1962-65, Fig. 8; 1966-69, Fig. 9; 1970-73, Fig. 10; 1974-78, Fig. 11.

In 1962-65, anchovy sightings were evenly distributed between Pt. Hueneme and Dana Point, in the Catalina Channel, and about Catalina Island. Sightings were less frequent south of Dana Point to San Diego. From 1966 to 1969, the observations were centered in the Catalina Channel and numerous observations were also made off the coast from Long Beach to Newport Beach.

From 1970 to 1973, the major observation areas were again near the center of the Catalina Channel, with sightings extending northwest from the Channel south of Pt. Dume.

Sighting occurrences for 1974-78 appeared to "clump" in the Catalina Channel area, extending from southeast of Long Beach to near Pt. Dume. 1978 sightings were more scattered throughout the area, except for high density areas of sightings southeast of Pt. Dume.

Index Trends.—The northern anchovy night index trend (Figs. 12, 13) was somewhat constant during 1963-69, with an average night index level of 3.50. The commercial catch increased sharply in 1969 and 1970, then declined in 1972. A period of warm sea surface temperatures which were well above average, occurred from August to December 1972 in the northeastern Pacific (Miller and Laurs 1975), and anomalous warm temperatures may have affected anchovy availability.

The index rose to 14.99 in 1973, and the commercial catch increased to near 117.9×10^3 t. Then, in 1974, a decline in index level and catch was evident. In 1975 the index increased to 11.38 and the catch increased to a record peak of 146.9×10^3 t. The catch decreased slightly in 1976 and 1977, then dropped to a very low level of about 16.3×10^3 t in 1978.

The aerial apparent abundance index declined in 1973-78 (see inspection fitted average line, Fig. 12), and this downward trend preceded the decline of the fishery. In 1975, the peak year of catch, the apparent abundance was not as great as it had been in 1973. However, sufficient fish were available in 1975, at an index level of 11.38, to meet the needs of the fishery. The 1978 apparent abundance index level of 1.91 was slightly below the index levels observed during the 1963-69 period. The total catch of anchovy in the central stock area, of which the southern California fishery is a part, was greater than the catch totals given in Figure 12, due to substantial quantities of anchovy landed and processed at Ensenada, Baja California, Mexico.

Night indices observed for the major fishing areas from near Santa Barbara to Dana Point, including the Channel Islands and San Pedro Channel, are shown in Figure 13. Zones G and H, the Catalina Channel, and the Catalina/14 mile bank area, were the major producing areas, and the highest indices were recorded for these areas. In 1978, a season of much reduced catches, the apparent abundance index increased for the Santa Barbara coastal area (zone C), the only anomalous trend observed.

Pacific Sardine

Morro Bay to San Nicolas Island.—1962-65, Fig. 14; 1966-69, Fig. 15.

The Pacific sardine fishery in the Monterey Bay area failed in the late 1940's. By the time the aerial monitoring survey program was started, little observation effort was being expended along the central California coast north of Morro Bay. In 1962-65, some flights were made along the coast from the south, to, and into, Monterey Bay. A few sardine schools were sighted in Monterey Bay but most were sighted along the coast south of Pt. Sur to Cape San Martin. Some schools were sighted from Morro Bay north (Fig. 14).

The last major catch of sardines off southern California was made near San Nicolas Island (lower right corner, Fig. 14), on opening day of the season, 1 September 1964. Prior to the season opening, aerial spotters estimated a maximum of about 9.1×10^3 t of sardines in the area. After the start of fishing, the sardine school group, which had been observed in the fishing area for 2 wk or more before the season opening, appeared to immediately start migrating southeast. After 2 d of fishing and a catch of about 2.7×10^3 t, only a few additional tons were taken in the San Nicolas Island area. During 1966-69 (Fig. 15), only a few small schools were sighted along the coast off Morro Bay, Avila, and Santa Barbara.

Pt. Hueneme to San Diego.—1962-65, Fig. 16; 1966-69, Fig. 17; 1970-73, Fig. 18.

During 1962-65, sardines were most frequently sighted in the San Pedro Channel south of Los Angeles Harbor, and near Catalina Island. In 1966-69, only six sightings were recorded off the Los Angeles area and southwest of San Clemente Island. The 1970-73 chart shows a small number of sightings off La Jolla, near San Diego. Since 1974, the aerial spotters have not sighted any individual schools of sardines.

Index Trends.—The pelagic resource aerial monitoring program was started after the major decline in sardine abundance occurred. However, the aerial index gives an insight into the last declining years of a once major resource (Fig. 19). In 1964, the catch was only about 6.4×10^3 t and the night index value was about 1.00; it was the last year sardines were caught in any quantity off southern California. In 1965, the index level declined to a very low level and has remained at a 0.00 level since. No individual schools of sardines have been recorded since 1973.

Pacific Bonito

Morro Bay to San Nicolas Island.—1962-65, Fig. 20; 1966-69, Fig. 21; 1970-73, Fig. 22; 1974-78, Fig. 23.

The geographical distribution of Pacific bonito sightings in this area changed little during the survey period. They were frequently sighted along the coast from east of Pt. Conception to near Ventura, around Anacapa Island, Santa Cruz Island, and near the southeast side of Santa Rosa Island. They were more frequently observed along the south side of Santa Cruz Island. During 1974-78, the frequency of sightings decreased, but the general distribution of sightings remained the same.

Pt. Hueneme to San Diego.—1962-65, Fig. 24; 1966-69, Fig. 25; 1970-73, Fig. 26; 1974-78, Fig. 27.

The geographical distribution of sightings changed little in this area from 1962 to 1978. As in the case of the northern anchovy, the distribution pattern of Pacific bonito since the mid-1960's has become more restricted, with sightings being found closer to the mainland coast and islands. The frequency of sightings peaked during 1966-69, with the major sighting area being from the Coronado Islands, Mexico, to Dana Point. In 1970-73, however, they were more commonly observed off San Diego. Sightings of Pacific bonito were fewer in number during 1974-78, and the 1978 sightings were primarily off Dana Point, Newport Beach, and Pt. Dume.

Index Trends.—Pacific bonito increased in abundance off California during the warm years of 1957-58 and was fished lightly between that time and 1965. Due to decreases in the availability or abundance of the Pacific sardine, Pacific mackerel, and jack mackerel, Pacific bonito became a target species. Catches off California more than doubled between 1965 and 1966, peaking with a catch of about 9.2×10^3 t.

The day apparent abundance index (Fig. 28) remained at an average level of 1.44, 1963-67, then decreased sharply to 0.43 in 1968, and to 0.26 in 1969. The catch declined about one-third during this period. No data was available for June-December 1970, but the first half-year data (normally low) indicated few schools were observed. The index increased to a peak of 1.11 in 1972, possibly due to an anomalous warm period in the northeastern Pacific during the summer and fall of 1972, which may have caused an increased migration of Pacific bonito into southern California from off northwestern Mexico. The index declined sharply in 1973 to 0.39, while catches off California increased to a level of about 8.2×10^3 t. The day index continued to decline over the years 1973-78 to a very low level, 0.12. Catches declined sharply in 1975 to the 1.8 to 2.7×10^3 t level and remained low, with a California catch of 1.2×10^3 t reported in 1978.

The major sighting areas for Pacific bonito (Fig. 29) were the Santa Barbara coast and Channel Islands (zones C and D) and the coastal area from near San Diego to Dana Point (zone J). The south coastal zone (J) had high index levels in 1963 and 1966 (record high for any one area) through 1971. The Santa Barbara coast and Channel zone (C) was the high index area for 1964, 1965, 1972, 1974, and 1975. Since 1972, index values for all areas declined to the low levels observed in 1977. In 1978, the night index increased to 0.94 as Pacific bonito were observed in greater quantities at night than during the day, a situation that occurred only in one other year, 1973.

Pacific Mackerel

Morro Bay to San Nicolas Island.—1962-65, Fig. 30; 1966-69, Fig. 31; 1974-78, Fig. 32.

In the area of Morro Bay to San Nicolas Island, Pacific mackerel were commonly sighted in the Santa Barbara Channel area and about the Channel Islands during 1962-65. Concentrations were sighted along the coast from east of Pt. Conception to near Ventura, with a center of sighting near Santa Barbara. Some schools were sighted along the north coast of Santa Cruz Island and the south side of Anacapa, and on the north side of San Nicolas Island. During 1966-69, only 21 schools or school groups were sighted, most of which were along the Santa Barbara coast. No schools were recorded for 1970 and 1974, but in 1977 and 1978, Pacific mackerel schools were again sighted about the Santa Barbara Channel Islands in large numbers, as shown on the 1974-78 charts. Between 1974 and 1977, 54 schools or school groups were recorded; in 1978, 74 were sighted.

During the 1962-65 period which preceded the decline of the Pacific mackerel resource to a very low level, most schools were sighted most frequently along the Santa Barbara coastline, and less frequently around Santa Cruz and Anacapa Islands. In contrast, during 1977 and 1978, only 11 schools or school groups were sighted along or near the Santa Barbara coast, while 117 schools or school groups were sighted off the north and southeast coasts of Santa Cruz Island and about Anacapa Island, indicating a shift in distribution pattern from the coast to about the Santa Barbara Channel Islands.

Pt. Hueneme to San Diego.—1962-65, Fig. 33; 1966-69, Fig. 34; 1970-73, Fig. 35; 1974-78, Fig. 36.

During 1962-65, the principal centers of sighting were around the east end of Catalina Island, and south of Long Beach. Pacific mackerel were also sighted at scattered locations along the coast from San Diego to Pt. Hueneme, and around San Clemente Island, Santa Barbara Island, and Cortez Bank. Few schools or school groups were sighted during 1966-69 or 1970-74, but a substantial

Table 3.—Annual indices of abundance for day and night observations. A dash (-/-) indicates no flight observations in the zone, 0.00 indicates observation effort in four places.

Zone	1962	1963	1964	1965	1966	1967	1968	1969	1970 (Jan. thru June)
NORTHERN ANCHOVY									
A	0.51/1.22	10.98/13.28	0.80/7.32	2.51/2.48	2.02/ 6.33	1.15/-	0.2820/-	0.00 /0.00	-/-
B	3.25/3.18	6.17/13.02	4.08/3.08	1.85/5.75	0.29/15.31	0.28/ 0.30	0.7346/-	0.0317/0.00	0.0714/-
C	0.05/0.99	0.40/ 2.70	0.90/2.85	1.82/8.63	0.27/ 2.79	2.91/ 3.03	0.0476/1.7637	0.8769/1.9387	0.3240/ 0.6387
D	0.00/2.97	1.24/10.02	0.23/4.75	0.48/3.67	0.14/ 6.73	0.63/ 5.12	0.0453/3.2438	0.4124/1.9662	0.0300/ 0.8163
E	-/0.00	0.00/ 1.05	0.00/3.14	0.00/0.12	1.09/ 0.23	3.15/ 0.11	0.1881/0.1284	0.3218/0.6701	0.6666/ 0.00
F	-/0.00	3.66/ 1.71	5.75/0.37	0.00/0.58	0.00/ 2.61	0.00/ 0.00	0.00 /0.6000	0.00 /0.00	-/ 0.00
G	-/1.00	0.51/ 1.81	0.54/6.21	1.42/3.23	2.24/ 1.78	2.40/ 8.32	0.5518/2.1056	5.0145/3.5780	31.7112/17.5166
H	-/-	0.14/ 0.12	0.38/1.00	0.05/1.90	2.28/ 1.43	5.45/ 1.60	0.6469/0.5820	6.3597/3.2604	17.9724/ 0.9949
I	-/-	0.14/ 0.00	0.05/0.11	0.02/0.34	0.28/ 2.53	2.87/ 0.71	0.1801/0.2116	0.7862/0.4971	0.00 / 0.8288
J	-/-	0.78/ 0.67	0.85/6.08	0.00/8.00	0.45/ 1.55	0.16/20.16	0.5282/1.1156	0.5536/3.3989	1.6282/46.5483
K	-/-	0.00/-	0.00/-	0.00/-	0.00/ 0.22	0.00/ 0.70	2.4400/0.0625	0.00 /0.00	-/-
L									
M									
N									
O									
P									
Average all zones	1.79/1.99	1.64/2.99	1.03/3.90	0.96/4.18	0.84/3.62	1.78/4.30	1.3274/1.4599	1.3043/4.3562	6.6325/8.8341
Average D+N						2.54	0.7183	2.4393	
PACIFIC BONITO									
A	0.00/0.00	0.00/0.00	0.50/0.00	0.00/0.00	0.04/0.00	0.07/-	0.0099/-	0.00 /0.00	-/-
B	0.01/0.00	0.00/0.01	0.06/0.01	0.02/0.00	0.43/0.00	0.01/0.00	0.00 /-	0.00 /0.00	0.00 /-
C	0.62/0.25	3.63/1.51	2.40/0.82	2.18/0.40	1.38/0.83	0.51/1.02	0.3617/1.3603	0.2994/0.2715	0.00 /0.0806
D	0.83/0.63	0.65/1.88	1.40/0.12	0.85/0.10	1.27/0.54	0.38/0.80	0.5285/0.1549	0.2433/0.2300	0.0057/0.5867
E	-/0.00	0.02/1.15	0.50/0.00	6.81/0.00	4.30/0.00	0.00/0.00	0.00 /0.0229	0.00 /0.00	0.00 /0.00
F	-/0.00	0.00/0.00	0.43/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.00 /0.00	-/0.00
G	-/0.00	0.31/0.37	0.30/0.00	0.50/0.01	1.19/0.16	0.67/0.39	0.1196/0.1302	0.1258/0.1666	0.0048/0.00
H	-/-	0.85/0.22	2.12/0.53	2.06/0.32	0.03/0.00	0.00/0.02	0.6805/0.2398	0.0907/0.0607	0.0689/0.0761
I	-/-	0.00/0.45	3.46/0.54	0.40/0.13	0.06/0.02	0.12/0.00	0.0275/0.0330	0.0203/0.0574	0.00 /0.1801
J	-/-	3.67/0.23	1.10/0.06	1.71/0.46	4.96/0.11	3.27/0.12	1.7038/0.6872	0.6464/0.0518	0.00 /0.00
K	-/-	0.13/-	0.00/-	0.00/-	0.00/0.00	45.73/0.00	0.2666/0.00	0.7547/0.00	-/-
L									
M									
N									
O									
P									
Average all zones	0.23/0.19	1.62/0.68	1.62/0.28	1.26/0.19	1.34/0.35	1.35/0.34	0.4325/0.3477	0.2682/0.1815	0.0059/0.1000
Average D+N						1.05	0.4032	0.2359	
JACK MACKEREL									
A	0.00/0.08	1.81/ 0.00	8.32/2.89	0.78/ 1.67	4.29/25.72	0.81/-	0.9153/-	0.0290/ 0.00	-/-
B	0.02/0.00	3.48/ 1.37	6.65/6.67	1.03/ 1.22	0.74/ 8.78	0.78/ 1.34	0.6966/-	0.00 / 0.00	0.00 /-
C	1.59/0.45	0.96/ 0.49	0.83/0.56	0.14/ 0.33	0.06/ 0.03	0.04/ 0.33	0.1319/ 0.0238	0.1150/ 0.1725	0.3065/ 0.3225
D	0.00/1.45	1.79/13.77	2.72/5.36	1.44/ 1.40	0.24/ 1.62	0.41/ 0.24	0.2064/ 0.1962	0.1544/ 0.3300	0.0607/ 0.1785
E	-/0.00	0.27/ 4.74	0.93/2.31	0.72/ 1.55	0.16/ 7.38	0.00/ 2.15	0.2475/ 4.0917	0.00 / 4.4175	0.00 / 0.00
F	-/2.91	11.16/39.70	1.63/2.31	0.00/17.41	0.00/27.91	0.00/38.84	10.8714/27.7731	3.5696/13.0833	-/12.3148
G	-/-	1.23/ 1.76	0.64/0.99	0.02/ 0.29	0.00/ 1.05	0.00/ 0.10	0.0239/ 0.0072	0.1394/ 0.2673	0.0339/ 0.0119
H	-/-	0.56/ 1.34	0.01/1.11	0.71/ 0.43	0.04/ 2.18	0.01/ 0.33	0.00 / 0.2665	0.00 / 0.5998	0.0172/ 0.3045
I	-/-	2.11/ 5.53	0.17/1.86	1.35/ 0.75	0.19/ 2.37	0.04/ 3.27	0.0045/ 1.2764	0.0489/ 1.5833	0.4090/ 0.7432
J	-/-	0.67/ 0.54	0.72/1.51	0.86/ 0.96	0.00/ 0.06	0.00/ 0.03	0.0855/ 1.0799	0.0616/ 0.3058	0.6410/ 2.1129
K	-/-	0.00/-	0.00/-	0.00/-	0.00/ 0.00	0.00/ 1.75	0.00 / 1.0937	0.00 / 0.00	-/-
L									
M									
N									
O									
P									
Average all zones	0.51/0.46	1.41/2.98	1.62/2.18	0.71/1.36	0.28/1.94	0.20/1.41	0.3044/2.2488	0.1119/0.6562	0.1648/0.5843
Average D+N						0.56	0.9754	0.3143	

zone but no fish sighted. Indices given as day/night. 1962 to 1967 data inconsistent regarding number of decimal places, all to two places plus; after 1968 all carried to

1971	1972	1973	1974	1975	1976	1977	1978
-/-	-/-	0.2857/-	0.00 /-	-/-	-/-	-/-	-/-
0.2592/0.00	0.00 /0.00	1.1111/ 7.6222	0.00 /-	0.1250/ 0.00	0.00 / 0.3030	0.304 /0.00	0.00 /-
0.6580/3.0459	0.8916/1.9063	0.5449/ 8.0520	0.2983/ 7.1637	4.1790/ 5.3511	3.6930/ 4.0366	4.23 /2.913	0.3478/8.3585
0.1368/2.1839	0.3668/0.7927	1.8384/ 1.7935	1.4139/ 5.2212	1.6621/ 4.0351	1.2133/ 4.1187	4.678 /6.34	7.5962/1.9864
0.2295/0.00	0.00 /0.1346	0.1200/ 0.00	0.7010/ 0.00	0.00 / 0.00	0.00 / 0.00	0.00 /0.054	0.8298/0.00
0.00 /0.00	0.00 /0.0674	16.2553/ 0.00	6.3235/ 1.3113	0.00 / 0.00	0.00 / 0.00	0.00 /0.00	0.00 /0.00
6.5099/8.7620	5.7211/3.5333	8.0516/25.7464	7.5068/11.3228	10.9772/18.1811	3.3894/ 8.4065	3.794 /6.6817	1.3494/1.1229
3.1002/1.1379	0.7711/0.0522	6.5606/18.8580	4.7102/ 6.8398	1.4856/ 2.0287	2.2903/ 3.0512	1.408 /2.059	1.3961/0.1747
0.3917/0.1228	0.5371/0.1363	2.1185/ 7.2598	0.3564/ 2.6627	0.2514/ 0.00	0.00 / 0.8730	0.4216/0.1498	1.6298/0.5993
0.7907/0.0555	1.5934/0.00	0.4207/ 9.2647	1.3235/ 0.1707	0.9050/ 1.3255	0.4436/10.0188	1.3015/2.253	2.3155/0.0354
0.00 /-	0.00 /0.00	0.2732/ 0.00	0.1403/ 4.0588	0.00 /-	0.00 / 0.0952	0.028 /-	0.8249/-
		0.1996/ 0.00	0.00 /-	1.3075/-	0.0080/ 0.0615	0.1430/2.307	3.1106/-
		0.00 / 0.00	0.00 /-	0.00 /-	0.00 /-	0.00 /-	0.00 /-
		0.00 /-	0.3216/-	0.00 /-	0.3265/ 0.00	0.9308/0.6909	0.00 /-
		-/-	0.00 /-	-/-	-/-	-/-	-/-
		0.1273/-	0.00 /-	0.00 /-	0.0293/ 0.00	2.765/0.2413	0.00 /-
1.1893/2.3107	1.3155/1.4058	2.4401/14.9912	2.0443/7.9060	3.9212/11.3889	1.5046/5.3696	2.1849/4.639	2.0742/1.9153
1.5962	1.3486	5.8869	3.8738	6.0923	2.2800	3.4003	2.0118
-/-	-/-	0.00 /-	0.00 /-	-/-	-/-	-/-	-/-
0.00 /0.00	1.7808/0.00	0.5158/0.00	3.5294/-	0.00 /0.00	0.00 /0.00	0.00 /0.00	-/-
0.1971/0.8846	2.0008/0.6135	1.0244/0.9090	0.8467/1.0172	0.4319/0.00	0.2324/0.0076	0.1741/0.00	0.1085/0.00
0.1732/0.0324	0.4746/0.1506	1.3562/0.8664	0.0776/0.0075	0.4005/0.0067	0.1595/0.00	0.00 /0.00	0.00 /1.9514
0.0409/0.00	0.00 /0.061	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00
0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.008 /0.0253	0.00 /0.00
0.1627/0.0094	0.0036/0.0031	0.1318/0.0707	0.0043/0.0098	0.0014/0.0035	0.0118/0.00	0.0109/0.00	0.1039/0.6735
0.00 /0.0029	0.00 /0.0672	0.0220/0.0453	0.0051/0.0188	0.00 /0.00	0.0067/0.00	0.0109/0.00	0.00 /0.0075
0.0128/0.00	0.00 /0.0239	0.0098/0.0196	0.0166/0.00	0.00 /0.00	0.0129/0.00	0.00 /0.5381	0.00 /0.0177
2.6452/0.8333	0.0102/0.00	0.8039/0.0490	0.3975/0.00	0.0035/0.00	0.1817/0.00	0.1020/0.053	0.8451/6.2247
0.2857/-	0.00 /0.00	0.00 /0.00	0.0054/0.00	0.00 /-	0.00 /0.00	0.00 /-	0.00 /-
		0.1068/0.00	0.0710/0.00	0.00 /-	0.0013/0.00	0.00 /0.00	0.00 /-
		0.00 /0.00	0.00 /-	0.00 /-	0.00 /-	0.00 /-	0.00 /-
		0.0056/-	0.1444/0.00	0.00 /-	0.00 /0.00	0.00 /0.00	0.00 /-
		-/-	0.00 /-	-/-	-/-	-/-	-/-
		0.00 /-	0.00 /-	0.8928/-	0.00 /0.00	0.00 /0.00	0.00 /-
0.5530/0.1516	1.1171/0.1993	0.3944/0.3902	0.2492/01775	0.0860/0.0027	0.0748/0.0021	0.0390/0.0386	0.1268/0.9380
0.4073	0.7807	0.3932	0.2268	0.0608	0.0602	0.0388	0.4455
-/-	-/-	0.00 /-	0.00 /-	-/-	-/-	-/-	-/-
0.00 / 0.00	0.00 /0.00	0.00 /0.00	0.00 /-	0.00 / 0.00	0.00 /0.00	0.00 / 0.00	-/-
0.0267/ 0.0600	0.0024/0.0050	0.0018/0.00	0.00 /0.0948	0.00 / 0.0413	0.00 /1.4669	0.0223/ 0.5589	0.0089/ 0.00
0.0632/ 0.0216	0.0071/0.2349	0.00 /0.00	0.0032/0.0151	0.00 / 0.0067	0.3110/1.2332	0.2959/ 3.1454	0.1687/ 1.8643
0.00 / 5.4017	0.00 /0.0961	0.00 /0.00	0.00 /6.1830	0.00 / 0.6250	0.00 /0.00	0.00 / 1.3949	0.00 / 0.9315
3.3700/10.4297	0.00 /6.4061	0.3723/0.6862	1.3088/3.3473	0.00 /37.5000	0.7614/4.0483	0.00 /27.2615	9.1818/14.6290
0.0180/ 0.1581	0.0036/0.0534	0.0156/0.0415	0.0172/0.0984	0.00 / 0.0172	0.0768/0.1725	0.3359/ 1.5846	2.4415/ 4.9477
0.00 / 1.3275	0.00 /0.3417	0.00 /0.0075	0.0357/0.1190	0.2396/ 2.0881	0.0271/1.5528	0.2008/ 3.6547	2.3239/10.8547
0.0128/ 1.1978	3.5087/0.3480	0.00 /1.0669	0.0367/0.9224	0.6814/ 5.7410	0.1077/1.6349	0.7458/ 0.7779	5.2704/ 1.8989
0.0148/ 0.00	0.0205/0.00	0.0012/0.00	0.0051/0.00	0.00 / 0.00	0.1362/0.00	0.1275/ 0.2298	0.00 / 0.00
0.00 /-	0.0641/0.00	0.0206/0.00	0.00 /0.00	0.00 /-	0.00 /0.00	0.0354/-	0.00 /-
		0.00 /0.00	0.00 /-	0.00 /-	0.00 /0.00	0.00 / 0.00	0.00 /-
		0.00 /0.00	0.00 /-	0.00 /-	0.00 /-	0.00 /-	0.00 /-
		0.00 /-	0.00 /-	0.00 /-	0.00 /0.00	0.00 / 0.00	0.00 /-
		-/-	0.00 /-	-/-	-/-	-/-	0.00 /-
		0.00 /-	0.00 /-	0.00 /-	0.00 /0.00	0.00 / 0.00	0.00 /-
0.0449/0.9225	0.1325/0.7388	0.0066/0.0603	0.0274/0.4350	0.0761/0.4013	0.0817/0.8735	0.1944/2.7751	1.1847/4.2077
0.3633	0.6983	0.0213	0.1546	0.1708	0.2406	1.4726	2.3724

Table 3.—*Continued.*

Zone	1962	1963	1964	1965	1966	1967	1968	1969	1970 (Jan. thru June)
PACIFIC MACKEREL									
A	0.00/ 0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/-	0.00/-	0.00/0.00	-/-
B	0.30/ 0.03	0.00/1.56	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/-	0.00/0.00	0.00/0.00
C	0.00/ 3.15	0.23/0.37	0.03/0.30	0.04/0.28	0.01/0.35	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00
D	0.50/ 0.30	1.41/2.20	0.49/0.23	0.05/0.08	0.00/0.01	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00
E	-/ 3.75	0.43/0.67	0.02/0.74	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.0366	0.00/0.00	0.00/0.00
F	-/ 0.00	5.40/6.59	3.15/3.62	0.00/0.23	0.00/2.95	0.00/0.00	0.00/0.0051	0.00/0.00	0.00/0.00
G	-/18.75	0.79/0.46	0.78/0.13	0.00/0.44	0.00/0.04	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00
H	-/-	2.19/1.62	0.14/0.36	0.00/0.02	0.00/0.02	0.00/0.00	0.00/0.0042	0.00/0.0347	0.00/0.0050
I	-/-	0.76/0.40	0.01/0.53	0.00/0.11	0.00/0.09	0.00/0.02	0.00/0.00	0.00/0.0402	0.00/0.0180
J	-/-	0.83/1.44	0.75/0.29	0.00/0.36	0.00/0.06	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00
K	-/-	1.94/-	0.00/-	0.00/-	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	-/-
L									
M									
N									
O									
P									
Average all zones	0.17/1.26	0.79/0.91	0.33/0.33	0.01/0.19	0.00/0.14	0.00/0.00	0.00/0.0022	0.0001/0.0096	0.00/0.0028
Average D+N						0.0020	0.0007	0.0036	-
PACIFIC SARDINE									
A	0.00/ 0.00	1.40/3.78	1.22/0.05	0.04/0.00	0.00/0.00	0.00/-	0.00/-	0.00/0.00	-/-
B	0.05/ 2.13	0.31/0.00	0.26/1.63	0.00/0.00	0.00/0.38	0.00/0.00	0.00/0.00	0.00/0.00	0.00 /-
C	0.04/ 0.00	0.02/0.00	0.00/0.05	0.07/0.02	0.00/0.00	0.00/0.03	0.00/0.00	0.00/0.00	0.00 /0.00
D	0.00/ 0.28	0.07/2.36	0.23/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00 /0.00
E	-/12.50	2.22/0.83	1.75/7.87	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00 /0.00
F	-/ 0.00	0.00/0.00	13.47/1.62	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	-/0.00	0.00 /0.00
G	-/ 0.00	0.08/0.30	0.17/0.13	0.03/0.00	0.00/0.09	0.00/0.00	0.00/0.00	0.00/0.00	0.00 /0.00
H	- -	0.06/0.67	0.00/2.27	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.0213	0.00/0.00	0.00 /0.00
I	- -	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.02	0.00/0.00	0.00/0.00	0.00/0.00	0.00 /0.00
J	- -	0.12/0.05	0.22/0.01	0.00/1.09	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.2564/0.00
K	- -	0.00/-	0.00/-	0.00/-	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	-/-
L									
M									
N									
O									
P									
Average all zones	0.04/1.00	0.22/0.50	0.27/1.03	0.02/0.05	0.00/0.04	0.00/0.0078	0.00/0.0022	0.00/0.00	0.0067/0.00
Average D+N						0.0023	0.0007	0.0000	
PACIFIC BARRACUDA									
A	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/-	0.00 /-	0.00 /0.00	-/-
B	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.24/0.00	0.00/0.00	0.00 /-	0.00 /0.00	0.00 /-
C	0.00/0.00	0.34/0.43	0.45/0.48	0.25/0.00	0.02/0.00	0.02/0.00	0.0382/0.0119	0.0422/0.00	0.0199/0.00
D	0.00/0.00	0.00/0.00	0.00/0.01	0.00/0.00	0.01/0.00	0.00/0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00
E	-/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00
F	-/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.00 /0.00	-/0.00
G	-/0.00	0.00/0.11	0.00/0.00	0.02/0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00
H	- -	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.11/0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00
I		0.15/0.00	0.00/0.31	0.40/0.00	0.02/0.00	0.01/0.00	0.00 /0.00	0.0016/0.00	0.00 /0.00
J	- -	0.04/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.0429/0.00	0.00 /0.00
K	- -	0.00/-	0.00/-	0.00/-	0.00/0.00	0.00/0.00	0.00 /0.00	0.00 /0.00	-/-
L									
M									
N									
O									
P									
Average all zones	0.00/0.00	0.08/0.15	0.08/0.12	0.10/0.00	0.03/0.00	0.00/0.00	0.0077/0.0016	0.0183/0.00	0.0084/0.00
Average D+N						0.0035	0.0056	0.0115	

1971	1972	1973	1974	1975	1976	1977	1978
-/-	-/-	0.00/-	0.00/-	-/-	-/-	-/-	-/-
0.00 /-	0.00 /0.00	0.00/0.00	0.00/-	0.00 /0.00	0.00 /0.00	0.00 / 0.00	0.00 /-
0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.00 /0.00	0.006/ 0.021	0.0092/ 0.0658
0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.00 /0.0394	0.357/ 1.31	1.1879/ 5.0309
0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.1292/0.00	0.00 / 0.00	3.4574/23.8452
0.6744/0.00	0.00 /0.2932	0.00/2.2058	0.00/0.00	0.00 /0.00	0.00 /0.00	0.223/ 8.0	2.7273/18.1452
0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.00 /0.00	0.006/ 0.82	1.1853/ 4.4186
0.0990/0.1315	0.00 /0.0047	0.00/0.00	0.00/0.00	0.00 /0.00	0.00 /0.00	5.45 / 8.41	9.6584/13.3682
0.0025/0.0451	0.00 /0.0492	0.00/0.00	0.00/0.00	0.0446/0.00	0.4707/0.00	3.61 /13.89	8.4372/30.2404
0.0005/0.00	0.0041/0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.0068/0.00	0.009/ 0.062	0.6338/ 4.9126
0.00 /-	0.00 /0.00	0.00/0.00	0.00/0.00	0.00 /-	0.00 /0.00	0.00 /-	0.00 /-
		0.00/0.00	0.00/-	0.00 /-	0.00 /0.00	0.00 / 0.00	0.00 /-
		0.00/0.00	0.00/-	0.00 /-	0.00 /-	0.00 /-	0.00 /-
		0.00/-	0.00/-	0.00 /-	0.00 /0.00	0.00 / 0.00	0.00 /-
		-/-	0.00/-	-/-	-/-	-/-	-/-
		0.00/-	0.00/-	0.00 /-	0.00 /0.00	0.00 / 0.00	0.00 /-
0.0042/0.0028	0.0003/0.0338	0.0000/0.0282	0.00/0.00	0.0035/0.00	0.0285/0.0066	0.907/2.62	2.1831/7.4608
0.0233	0.0126	0.0077	0.00	0.0025	0.0241	1.754	4.2566
-/-	-/-	0.00 /-	0.00/-	-/-	-/-	-/-	-/-
0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/-	0.00/0.00	0.00/0.00	0.00/0.00	0.00/-
0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00
0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00
0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00
0.00 /0.1000	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00
0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00
0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00
0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00
0.0207/0.00	0.0205/0.00	0.0102/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00
0.00 /-	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/-	0.00/0.00	0.00/-	0.00/-
		0.00 /0.00	0.00/-	0.00/-	0.00/0.00	0.00/0.00	0.00/-
		0.00 /0.00	0.00/-	0.00/-	0.00/-	0.00/-	0.00/-
		0.00 /-	0.00/-	0.00/-	0.00/0.00	0.00/0.00	0.00/-
		-/-	0.00/-	-/-	-/-	-/-	-/-
		0.00 /-	0.00/-	0.00/-	0.00/00.0	0.00/0.00	0.00/-
0.0030/0.0008	0.0015/0.00	0.019/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00
0.0023	0.0010	0.0013	0.00	0.00	0.00	0.00	0.00
-/-	-/-	0.00 /-	0.00 /-	-/-	-/-	-/-	- -
0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /-	0.00 /-	0.00 /0.00	0.00/0.00	0.00/-
0.0125/0.00	0.00 /0.00	0.0037/0.00	0.2688/0.00	0.0252/0.00	0.0396/0.00	0.00/0.00	0.00/0.00
0.00 /0.00	0.0856/0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00
0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00
0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00
0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00
0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00
0.00 /0.00	0.00 /0.00	0.00 /-	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00
0.00 /0.00	0.00 /0.00	-/-	0.0068/0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00
0.00 /-	0.00 /0.00	0.00 /-	0.00 /0.00	0.00 /-	0.00 /0.00	0.00/-	0.00/-
		0.00 /0.00	0.00 /-	0.00 /-	0.00 /0.00	0.00/0.00	0.00/-
		0.00 /0.00	0.00 /-	0.00 /-	0.00 /-	0.00/-	0.00/-
		0.00 /-	0.00 /-	0.00 /-	0.00 /0.00	0.00/0.00	0.00/-
		-/-	0.00 /-	-/-	-/-	-/-	- -
		0.00 /-	0.00 /-	0.00 /-	0.00 /0.00	0.00/0.00	0.00/-
0.0055/0.00	0.0190/0.00	0.0004/0.00	0.0407/0.00	0.0030/0.00	0.0053/0.00	0.00/0.00	0.00/0.00
0.0035	0.0120	0.0003	0.0260	0.0021	0.0042	0.00	0.00

Table 3.—*Continued.*

Zone	1962	1963	1964	1965	1966	1967	1968	1969	1970 (Jan. thru June)
YELLOWTAIL									
A	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/-	0.00 /-	0.00/0.00	-/-
B	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.07/0.00	0.00/0.00	0.00 /-	0.00/0.00	0.00/-
C	0.00/0.00	0.03/0.04	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.00/0.00	0.00/0.00
D	0.00/0.00	0.36/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.00/0.00	0.00/0.00
E	-/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.00/0.00	0.00/0.00
F	-/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.00/0.00	-/0.00
G	-/0.00	0.00/0.00	0.00/0.00	0.01/0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.00/0.00	0.00/0.00
H	-/-	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00/0.00	0.00 /0.00	0.00/0.00	0.00/0.00
I	-/-	0.55/0.64	0.13/0.04	0.34/0.07	0.39/0.00	0.09/0.00	0.00 /0.00	0.00/0.00	0.00/0.00
J	-/-	0.63/0.10	0.00/0.00	0.16/0.00	0.00/0.00	0.00/0.00	0.0037/0.00	0.00/0.00	0.00/0.00
K	-/-	0.00/-	0.00/-	0.00/-	0.00/0.00	0.00/0.00	0.00 /0.00	0.00/0.00	-/-
L									
M									
N									
O									
P									
Average all zones	0.00/ 0.00	0.19/ 0.06	0.01/ 0.00	0.06/ 0.00	0.04/ 0.00	0.00/ 0.00	0.0004/ 0.00	0.00/0.00	0.00/0.00
Average D+N						0.0023	0.0002	0.0000	—

increase in sightings occurred in this area during 1976-78. In 1976, 11 sightings were made about San Clemente Island, and 3 northwest of San Diego. In 1977, sightings totaled 210 with concentrations about Catalina and San Clemente Islands, and a small group of sightings about Cortez Bank and along the coast near Pt. Dume. Most of the increase in numbers of sightings occurred in the late summer and fall of 1977. In 1978, 321 sightings were made, and were concentrated about the southern California islands, including Santa Barbara Island. An increasing number of sightings occurred in the Catalina Channel south of Long Beach, and along the coast both east and west of Pt. Dume.

In recent years, Pacific mackerel have been sighted in many of the same areas as during the 1962-65 period, the exception being that sightings are not as common in the San Diego to Oceanside area.

Index Trends.—The aerial pelagic resource monitoring program was started after the major decline of the Pacific mackerel fishery had occurred. However, about the time the survey program was started (1963), and in the years following, a sequence of severe recruitment failures helped reduce the population to a very low level (MacCall et al. 1976). The biomass estimate in 1962 was about 99.8×10^3 t. By 1963, it had declined to about 54.4×10^3 t, and to a level of about 7.3×10^3 t in 1967. A catch moratorium was placed on the commercial fishery in 1970. In later years, this was modified and catches off California in 1977 and 1978 amounted to 3.8 and 13.2×10^3 t, respectively. The night index (Fig. 37) declined from about 0.91 in 1963 to 0.00 in 1967 and remained at a very low level through an 8-yr period, from 1967 to 1975. The catch also declined sharply from 18.1×10^3 t in 1963 to about 2.3×10^3 t in 1965. Historical records would indicate the Pacific mackerel is subject to rather severe fluctuations in recruitment. In 1976, a small increase in the index level was evident, and in 1977 the index level had increased dramatically to a level of about 2.62. In 1978, the 1977 level increased 2.8 times, to a level of 7.46. Within a 3-yr period, the Pacific mackerel went from zero observations of pure schools in 1974, to a condition in 1978 where it was one of the species frequently observed in substantial tonnage.

Jack Mackerel

Morro Bay to San Nicolas Island.—1962-65, Fig. 38; 1966-69, Fig. 39; 1970-73, Fig. 40; 1974-78, Fig. 41.

Jack mackerel were frequently sighted along the coast from Avila northward to Pt. Sur, and from Pt. Conception eastward in the Santa Barbara Channel, with centers of sightings in the Channel southeast of Santa Barbara about the eastern half of Santa Cruz Island, and Anacapa Island. Observations on the flight log charts, from 1962 through 1969, showed little change in areas and numbers sighted. Fewer sightings were made during 1970-73 about the Santa Barbara coast, Channel, and Islands, and this may have been related to the oil discharge in the Santa Barbara Channel in early 1970. During this period, less search effort was expended north of Pt. Conception, but the effort that was expended failed to note any concentrations. During 1976-78, jack mackerel were sighted in increasing numbers at the eastern end of the Santa Barbara Channel, and about Santa Cruz and Anacapa Islands, in the same areas as observed during 1962-69.

Pt. Hueneme to San Diego.—1962-65, Fig. 42; 1966-69, Fig. 43; 1970-73, Fig. 44; 1974-78, Fig. 45.

For the area from Pt. Hueneme to San Diego, there has been little change in the major sighting areas since 1962. Sightings declined during 1970-73, as in the Santa Barbara Channel area. In 1976-78, the sightings increased along the coast and about the islands and on Cortez Bank. During this period, the coastal area from southwest of Pt. Dume to Pt. Hueneme appeared to have a greater number of sightings than during 1962-65.

Index Trends.—The aerial night index level (Fig. 46) was about 2.98 in 1963, with a catch of 42.6×10^3 t. In 1964-67, the catch declined about one-third, but the aerial index did not show a declining trend. In 1969, the index dropped sharply to a 0.65 level and continued to decline through 1975 (0.40). In 1976, a small increase in the index was noted (0.87), rising to 2.77 in 1977. It then increased 1.5 times in 1978 to a record high of 4.20. The substantial increase in index level in 1977 and 1978 parallels, but does not equal in magnitude, the increase in the Pacific mackerel index. Both day and night indices for jack mackerel increased in 1978.

1971	1972	1973	1974	1975	1976	1977	1978
-/-	-/-	0.00 /-	0.00 /-	-/-	-/-	-/-	-/-
0.00/0.00	0.00 /0.00	0.00 /0.00	0.00 /-	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/-
0.00/0.00	0.0664/0.00	0.0074/0.00	0.0044/0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00
0.00/0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.0014/0.00	0.00/0.00	0.00/0.00
0.00/0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.0873/0.6451	0.00/0.00	0.00/0.00
0.00/0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00
0.00/0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00
0.00/0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/0.00
0.00/0.00	0.0109/0.00	0.00 /0.00	0.00 /0.00	0.0047/0.00	0.00 /0.00	0.00/0.00	0.00/0.00
0.00/-	0.00 /0.00	0.0460/0.00	0.2364/0.00	0.00 /0.00	0.00 /0.00	0.00/0.00	0.00/00.0
0.00/0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /-	0.00 /0.00	0.00/-	0.00/-
		0.00 /0.00	0.0106/-	0.00 /-	0.00 /0.00	0.00/0.00	0.00/-
		0.00 /0.00	0.00 /-	0.00 /-	0.00 /-	0.00/-	0.00/-
		0.2847/-	0.00 /-	0.00 /-	0.00 /0.00	0.00/0.00	0.00/-
		-/-	0.00 /-	-/-	-/-	-/-	0.00/-
		0.00 /-	0.00 /-	0.00 /-	0.00 /0.00	0.00/0.00	0.00/-
0.00/0.00	0.0035/0.00	0.0213/0.00	0.0470/0.00	0.0004/0.00	0.0015/0.0056	0.00/0.00	0.00/0.00
0.0000	0.0022	0.0155	0.0323	0.0003	0.0024	0.00	0.00

Bluefin tuna						
A	0.00 /-	0.00 /-	-/-	-/-	-/-	-/-
B	0.00 /0.00	0.00 /-	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00
C	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00
D	0.00 /0.00	0.0226/0.00	0.0386/0.00	0.00 /0.00	0.00 /0.00	0.00 /0.00
E	0.00 /0.00	0.0257/0.00	0.3281/0.00	0.0545/0.00	0.00 /0.00	0.00 /0.00
F	0.00 /0.00	0.6127/0.0449	0.00 /0.00	0.0458/0.7258	0.00 /0.00	0.00 /0.00
G	0.00 /0.00	0.0797/0.0410	0.0241/0.00	0.00 /0.0021	0.00 /0.00	0.00 /0.00
H	0.00 /0.00	0.0306/0.00	0.0279/0.00	0.0067/0.00	0.0072/0.00	0.00 /0.00
I	0.2667/0.00	0.2603/0.00	0.1228/0.00	1.2857/0.0396	0.034 /0.00	0.00 /0.00
J	0.0408/0.00	0.7556/0.00	0.0779/0.00	0.7330/0.00	0.00 /0.00	0.00 /0.00
K	3.0506/1.2878	1.9407/0.00	0.1034/-	1.6140/0.2380	0.14 /-	4.145/-
L	1.1499/0.5319	1.9779/-	0.3642/-	1.6190/0.00	0.00 /0.00	0.328/-
M	2.9545/0.00	0.00/-	0.00 /-	0.00 /-	0.00 /-	0.00 /-
N	2.4402/-	5.3768/-	0.7735/-	1.7961/0.00	4.44 /0.00	9.482/-
O	-/-	0.00/-	-/-	-/-	-/-	-/-
P	16.3561/	14.3181/-	0.00 /0.00	0.2495/0.00	0.037/0.00	2.142/-
Q				-/-	-/-	-/-
R				24.7204/0.00	-/-	-/-
Average all zones	0.9462/0.0276	0.7972/0.0202	0.1324/0.00	0.8766/0.0091	0.424/-	0.7183/0.00
Average D+N	0.6940	0.5547	0.0938	0.7026	0.2139	0.4361

Tunas

Bluefin tuna.—Sightings of bluefin tuna for all years 1962 through 1978, are given for the areas north of the United States-Mexico border (Figs. 47, 48), and for the area from San Diego south into Mexico (Fig. 49). Flight log charts for areas south of the border (see dotted line on Fig. 49) were not used by the program until 1974.

Figure 47 shows that the major sighting area for bluefin tuna in the Santa Barbara Channel and Channel Islands area was along the south side of Santa Cruz and Santa Rosa Islands, with a few sightings made near San Nicolas Island and along the Santa Barbara coast. Figure 48 shows that sightings were widely scattered west and southwest of San Diego. Bluefin tuna were frequently sighted about San Clemente Island, and along the coasts off Oceanside and Redondo Beach. In the southern area of fishing off Mexico (Fig. 49), sightings were more concentrated west and northwest of Ensenada. Aerial spotter operations were seldom conducted south of Pta. Baja, Mexico.

Index Trends.—For the period 1973-78 day index (Table 2), the index trend shows 1975 to have been the lowest in relative apparent abundance (0.13). The highest level was recorded in 1973 (0.95).

Albacore tuna.—For albacore tuna sightings, Figure 50 gives locations for all years 1962 through 1978. Figure 51, from the Coronado Islands, Mexico, southward to Pta. Baja, indicates sightings for the years 1974-78.

Albacore were sometimes sighted west and southwest of San Diego (Fig. 50), but few sightings were made north of this area. A total of 124 sightings were made during the survey period. Figure 51 indicates that 76 sightings were made west to northwest of Ensenada, but few were made in this area south of a line drawn west from Cabo Colnett, Mexico.

Other sightings

Although yellowtail, Pacific barracuda, white seabass, basking shark, and squid are not of primary interest to the commercial aerial fish spotter, records were maintained and are given for these species because they are of interest to the recreational or commercial fisheries of southern California.

Yellowtail.—Areas of sighting were about the Coronado Islands, Mexico, north to near Newport, along the northeast side of San Clemente Island (Fig. 52), and along the coast from Santa Barbara to Pt. Conception (Fig. 53)

Pacific barracuda.—Small numbers of sightings were made along the coast, from north of San Diego to near Long Beach, and off the northeast side of San Clemente Island (Fig. 54). Barracuda were also sighted along the coast from near Pt. Conception to Ventura (Fig. 55).

White seabass.—This species was more commonly sighted by the aerial spotters near Pt. Conception, along the north side of Santa Cruz Island (Fig. 56), and to the north off Avila, Morro Bay (Fig. 57), with some sightings recorded in the northern half of Monterey Bay.

Observations of basking shark (Figs. 58, 59) and of squid (Figs. 60, 61) are of interest to the commercial fishery and are given. Index values are not given for these species.

Basking shark.—Although many species of sharks were sighted, most were not indentified by the spotter pilots as to species. The exceptions were the large sharks, such as the basking shark which was the subject of a commercial fishery in the late 1940's and early 1950's. Aircraft were used in this fishery to locate basking sharks and, on occasions, great white sharks were observed (Squire 1967).

Basking sharks were quite common in coastal waters in the late 1940's and early 1950's, and at that time were fished commercially in California. They were sighted frequently off Avila and Morro Bay (Fig. 58) along the coast south of Pt. Sur, but most frequently in the central and northern half of Monterey Bay (Fig. 59). Few were observed in the mid- to late-1960's and early 1970's. Recently, more basking sharks were being sighted north along the coast from the Santa Barbara area west to Point Conception. A total of 1,911 basking sharks were recorded by the aerial spotters.

Squid.—The only invertebrate animal reported as being sighted in surface schools was the squid. Schools were most common about the eastern half of Santa Cruz Island and Anacapa Island (Fig. 60), and in the coastal area from Pt. Hueneme to Pt. Dume. They appeared most common about Catalina Island (Fig. 61), with larger concentrations along the southwest side. Distribution of sightings about San Clemente Island were grouped at the northwest and southeast ends.

DISCUSSION

Evaluation of Index Data

The aerial observation program relies on the assistance of commercial aerial spotters who, for a modest fee, provide flight log data. The limitations of the data must be recognized since they are nonrandom, and influenced by many variable factors.

Sighting.—The probabilty of sighting a school may be affected by a number of physical factors, some of which are common to both day and night operations, others to day or night (see Table 4). Economic factors are also very important in determining target species for search and location of area searched. In recent years, the demand for anchovy has increased and additional emphasis has been placed on searching areas where anchovy are commonly observed. However, these areas are frequently the same areas where other species are observed.

Table 4.—Physical factors affecting the probability of sighting a school. X = important, — = less important, and 0 = not a factor.

	Day	Night
Area observed	X	X
Angle of viewing	X	—
Sun position	X	0
Moon phase	0	X
School size	X	X
School depth	X	X
School density	X	—
Bioluminescence levels	0	X
Weather		
clear	X	0
overcast	X	0
haze	X	—
Configuration of aircraft	X	X
Ground speed differences	—	—

Identification.—The detection of near-surface schools during the day is dependent upon the pilot's ability to distinguish subtle color and light intensity differences in the water. Detection of schools at night is possible only during the dark phase of the moon, and depends on the pilot's ability to discern gradation of light intensity. Bioluminescence of planktonic organisms agitated by schooling fish indicates by a dull glow the location and size of the school.

Species are identified during the day on the basis of a combination of two or more of the following characteristics: color of school or individual fish, shape of school, and behavior and size of individuals within the school. At night, species identification is based on shape of the luminous area and behavior of the schooling fish under undisturbed conditions, or by the behavior of the school after being subjected to a stimulus from an external source such as a flash from the aircraft's landing light. A light flash causes a response or movement of the fish, which agitates the plankton, resulting in bioluminescence. The response of the fish to the light flash is species-distinctive and allows the trained observer to make an estimation of species. The level of bioluminescent plankton organisms, the schooling configurations, depth of school, and composition of the school (mixed species), are some of the variables in night identification.

School size estimation.—The probability of sighting, identifying, and estimating school size, is affected by the training and ability of the spotter pilot. It was recognized in the beginning of the program that variation in estimating school size probably has more effect on the data than other variables. Some spotter pilots consistently report greater tonnages than do others (Squire 1972). Six of the fish-spotter pilots have continued full-time with the program since 1963 and were the major contributors. Therefore, if biases in reporting of tonnage were present, it may have been relatively consistent throughout the period. MacCall,[3] in an investigation of aerial spotter variation in reported abundance of anchovies, found that differences in spotting power appeared to be consistent for both day and night conditions for two periods of time (1 ½ yr apart). He also stated that variability in reported tonnages was high even for consecutive flights, giving wide confidence intervals of estimates of spotting power and daily fish abundance. A long-term averaging, however, will reduce the variance in estimates of mean abundance. In evaluating comparative observations between pilots as presented in the flight log, we do not know if they were looking at the same school or school group at the same time. If they were observing the same school or school group, it is possible that some period of time may have elapsed between observations, and the availability level changed. Estimation values between pilots may also change by species, requiring corrective factors by pilot for each species. For example, the anchovy is sometimes one of the more difficult species to evaluate and estimate tonnage because of the large school groups and large tonnages available.

Pilot estimation values for anchovy were calculated using data for the period 15 September to 31 December 1966, 1969, 1974, 1976, and 1977. Flight logs of two or more spotter pilots were compared, using observations thought to be near the same geographical location, for either day or night. One aerial spotter, recognized among his peers as an able and competent observer, was selected as the key observer and his observations were used as a reference base. The results for observations for other spotter pilots indicate that, when compared with the key aerial spotter, two pilots were estimating nearly the same as the key pilot, three were 0.4 times his estimate, two were 0.45 times, and three about 0.08 times. The differences in spotting power appeared to be consistent both day and night, as found by MacCall (footnote 3).

Aerial spotter pilots tended to survey portions of the ocean near their bases of operation: either the greater Los Angeles area or the Santa Barbara coastal area. Pilots operating in the same area tended to estimate the available tonnage in similar amounts, for they frequently communicated via radio and tended to cooperate in the searching and fishing operations in their respective search and fishing areas. As indicated previously, no effort was made during the period of the survey to attempt to influence the individual aerial spotter's tonnage estimation values and the major contributors to the program have participated throughout its 16-yr period.

Comparison of Apparent Abundance Measuring Techniques

A precise measure of a specie's total abundance and its biological composition is most desirable for the management of pelagic marine species. However, at the present time a precise measure of abundance is not possible. Management must therefore rely on sampling techniques to obtain a reasonable estimate of abundance and biological composition. The major coastal pelagic resources are conveniently being measured by methods of sampling which provide a measure or index of apparent abundance (catch or observations per effort). Larval surveys provide an apparent abundance measure, and acoustical surveys are conducted to determine the apparent abundance of fish schools. These apparent abundance indices are then adjusted to yield an estimate of total abundance. For the years since the start of the aerial survey program, some data are available giving estimates for Pacific mackerel and northern anchovy. These data can be compared with the trend of the aerial apparent abundance index. Three types of independent survey data are available for comparison: the larval survey, acoustical or sonar surveys, and the aerial spotter surveys. For the following species, some comparative data are available.

Pacific Mackerel

Smith and Richardson (1977) presented a graph of three independent estimates of the abundance of Pacific mackerel (Fig. 62) using three index values: spawning biomass, larval index, and aerial index. The aerial index can only be compared with values obtained after the start of the aerial survey in 1963. A rank correlation test (Spearman) was used to examine the aerial index vs. spawning biomass (1963-67), giving a significant correlation ($r_s = 1.00$). For the aerial index vs. larval index comparison, the correlation coefficient was $r_s = 0.77$, not significant at the 0.05 level. Although the statistics show promising results, it should be noted that the data are limited by the number of years tested, and that the three indices show a common decrease in value.

Northern Anchovy

Three research programs using different techniques have independently developed apparent abundance data concerning the anchovy resource. Larval catch data have been summarized to produce a larval index and an estimate of spawning biomass. Acoustical surveys to measure school number and size have been used to develop an acoustical index and an estimate of biomass. Aerial survey data have been used to develop an index of apparent abundance. The larval and acoustical techniques sometimes used different indices through the years.

Since all estimates are independent of each other, an analysis was made to determine if these methods were estimating a common source. A description of the data sources for Figure 63 is as follows: larval abundance data for the central subpopulation for 1963 through 1972 was provided by Smith,[4] and data from 1972 through 1978 by Stauffer (1980). Acoustical surveys have been conducted since 1966, but acoustical techniques were changed in 1971. Therefore, acoustical data were compiled from Mais (1974, footnote 5). Aerial survey data taken off the coasts of southern California and northwestern Baja California, Mexico, from published records 1962-69 (Squire 1972), and records through 1978 included in this publication, are in Table 2. Figure 63 shows the larval index from 1963 to 1978, for the central subpopulation, the aerial night index, and acoustical index. The acoustical index is based on $N \times 10^3$ schools for the early years, and the school's surface area (square nautical miles) for the later years. The larval index uses the estimated abundance of larvae $\times 10^{12}$ for the central subpopulation.

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[4] P. E. Smith, Fishery Research Biologist, Southwest Fisheries Center La Jolla Laboratory, NMFS, NOAA, La Jolla, CA 92038, pers. commun. 1974.

[5] Mais, K. F. 1978. Acoustic survey for the assessment of anchovy resources off California and northern Baja California. Unpubl. manuscr., 21 p. California Department of Fish and Game, Marine Resources Laboratory, 350 Golden Shore, Long Beach, CA 90802.

Significant Spearman rank correlations were not found for comparison of aerial to larval and acoustical survey data for 1963-72. Comparison of aerial and acoustical survey indices for the period 1972-78 gave a significant correlation ($r_s=0.810$, $P=0.05$). During this period, only three larval surveys were conducted, not an adequate sample for calculating a correlation. MacCall et al. (1976) calculated a correlation coefficient of +0.30 for larvae vs. aerial (night) surveys during 1962-66, and for 1968 and 1969. More recently, an anchovy spawning biomass estimate based on egg production has been developed (MacCall et al. 1982). The correlation between the aerial (night) anchovy index with the new biomass estimate is very high (Fig. 64).

The aerial night index appears to be closely correlated with the acoustical index developed during the years since 1971. Larval surveys cover a larger geographical area than either the aerial or acoustical surveys, generally extending further offshore. The aerial survey involves only the nearshore area where the purse seine fishery operates. This area commonly has large concentrations of near-surface schooling fish and suitable sea-state conditions for purse seining, conditions which are not common in the offshore areas.

The anchovy night aerial abundance index was not unusually high during the first years of the surveys compared with levels observed in 1973-76. The aerial surveys were started about the time the anchovy population was reported by Ahlstrom (1968) to have reached a plateau in about 1962. The anchovy larvae index for the central subpopulation declined during 1965-72, increased slightly in 1975, then declined sharply in 1978. The aerial and sonar indices rose two or more times their former levels to high levels in 1973 and 1975, then declined, with the aerial index declining to slightly below pre-1972 levels.

The geographical area covered by the aerial survey program contained the major commercial fishing grounds. High abundance level indices from the aerial spotter data were not evident for this area, which apparently did not benefit from the high larval index levels that started in 1962 and resulted in population estimates of 4.0 to 5.0×10^6 t (Ahlstrom 1968). However, a significant but unexplained change to high aerial and acoustic index trends occurred in the fishery during 1973-75, prior to a rapid decline during 1976-78, in the larval, acoustical, and aerial indices.

Pacific Bonito

Studies have been made using the aerial day index of Pacific bonito observed off southern California, in correlation with recreational partyboat CPUE, using yearly time-lag periods (MacCall et al. 1976). The recreational fleet which fishes nearshore generally catches younger fish than the commercial purse seine fleet. The highest correlation between the recreational fleet CPUE and the aerial apparent abundance index for the commercial fishery was for a 3-yr lag period ($r=0.69$) which is shown in Figure 65. We believe this correlation to be useful in predicting recruitment into the commercial fishery, based on partyboat CPUE.

SUMMARY

The aerial index data is positively correlated with the trend of other measures of apparent abundance, particularly the acoustical survey (post-1971) for anchovy abundance. For the limited amount of comparable data available, the Pacific mackerel aerial index appears to correlate well with the biomass estimates. The index levels of Pacific bonito, a species that is more common to the south, show trends that appear to parallel the trend of the biomass.

Index trends for both the northern anchovy, beginning in 1974, and Pacific bonito, in 1968 and 1973, show a pronounced downward slope one to two years before major declines occurred in these fisheries.

This program has used the available talents of commercial fish spotters who use standard visual techniques to observe pelagic schooling fish. In recent years, airborne electronic surveillance systems specifically designed to measure the extent of the available near-surface schooling resources at night have been developed. These new techniques, if used in close coordination with commercial operations and research studies, could produce for the program a more refined estimate of apparent abundance, not only for the fishing areas commonly surveyed by the commercial spotters but also for areas farther offshore where resources such as the anchovy are commonly observed during the winter-spring spawning season.

All analyses to date have involved only the production of basic apparent abundance indices, and have not been further adjusted to produce a more refined index or estimates of biomass. The aerial apparent abundance data should be further analyzed to provide more refined estimates of abundance for the major pelagic species. Studies are currently in progress to do this.

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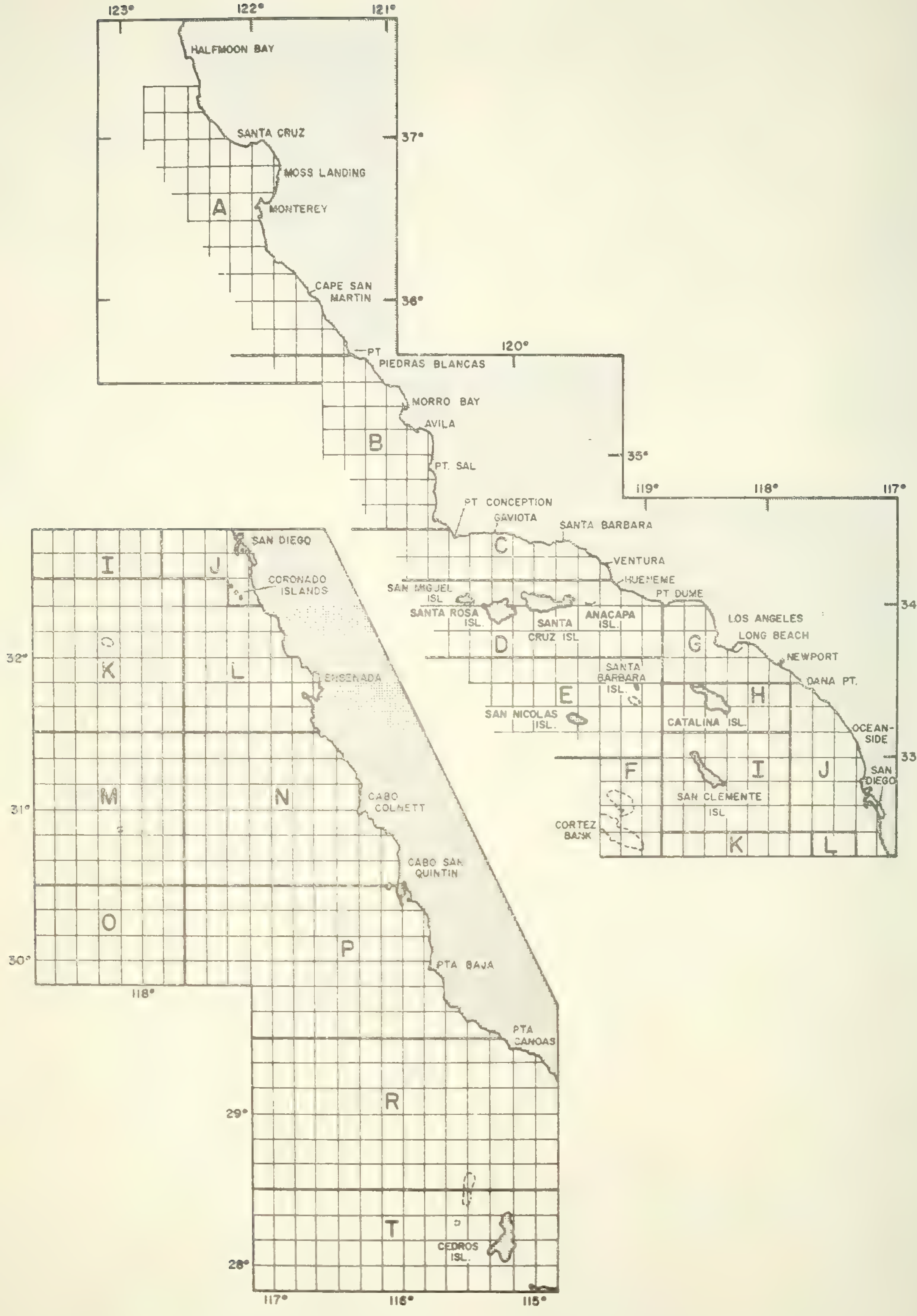


Figure 1.—Block areas from near Half Moon Bay, Calif., to Cedros Island, Baja California, Mexico, grouped in zones A to T as used in this study.

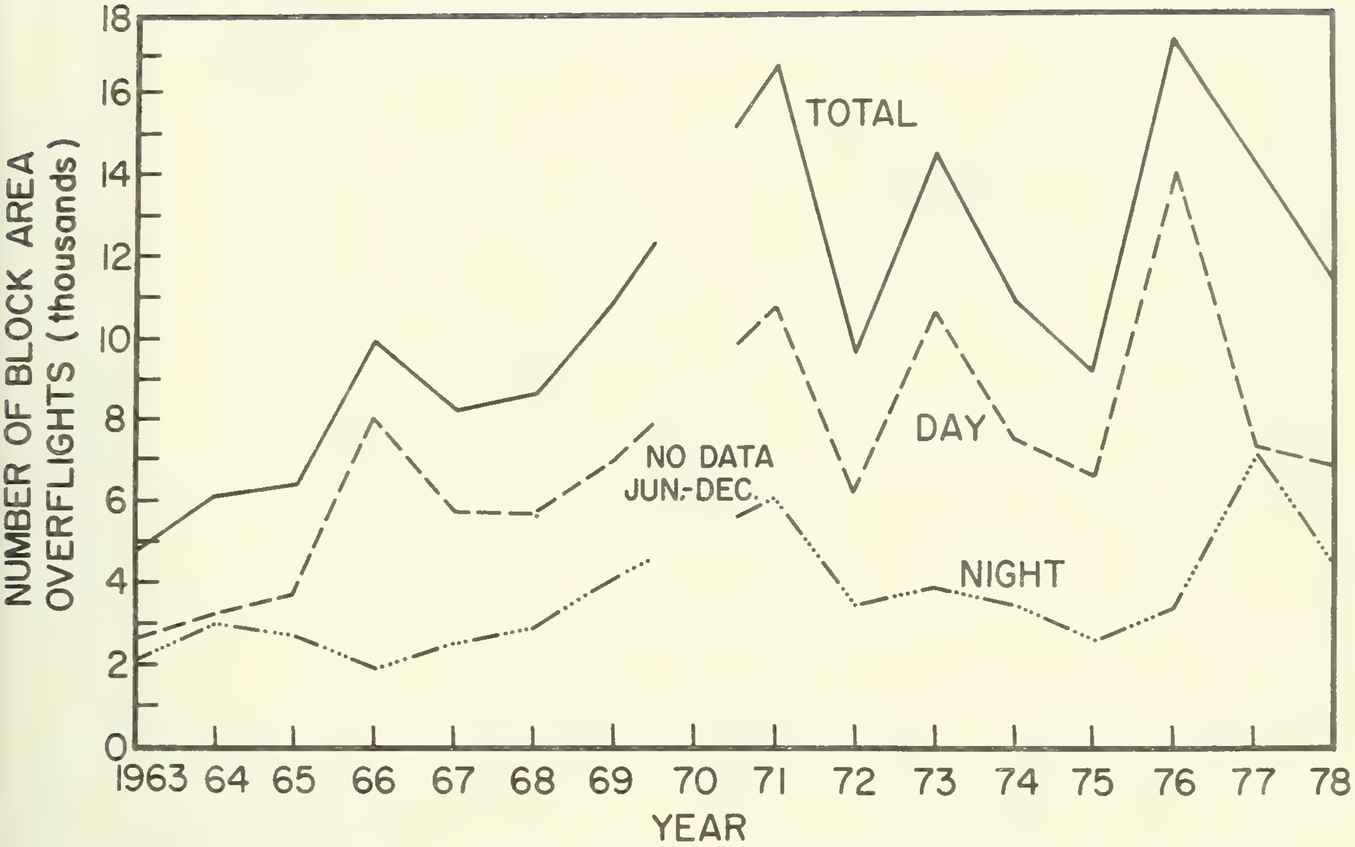


Figure 2.—Summary of observation effort, 1962-78, in terms of total day, night, and total overflights of block areas.

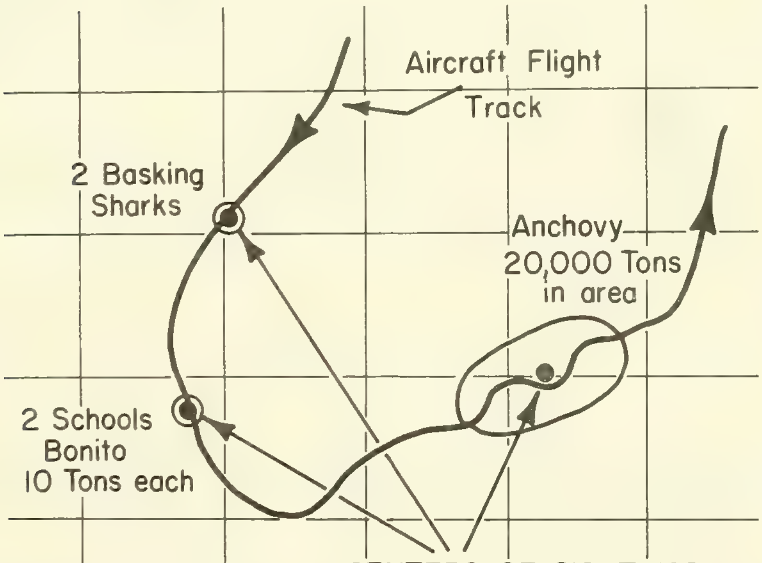


Figure 3.—Graphic description of positioning the center of sighting.

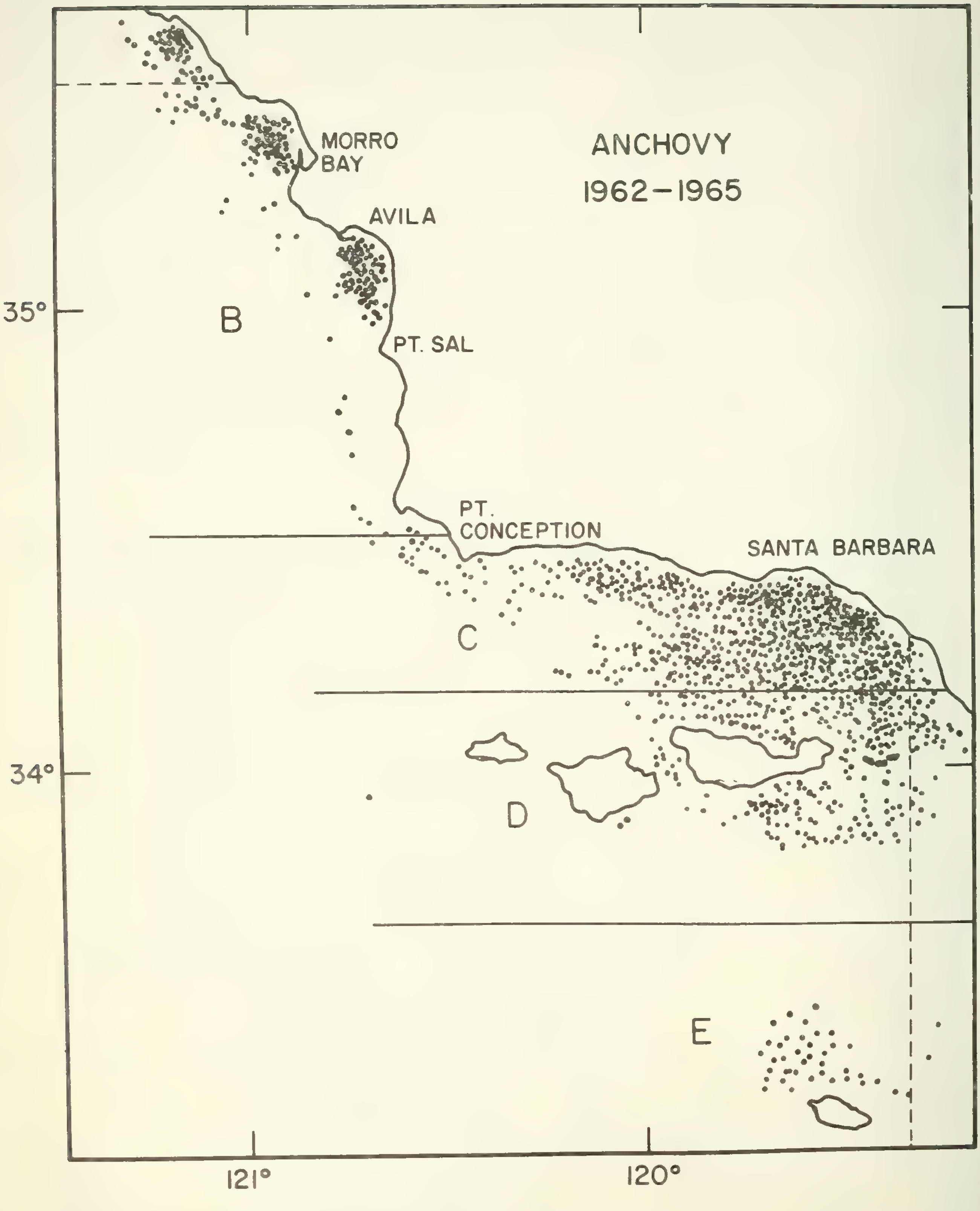


Figure 4.—Northern anchovy—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1962-65.

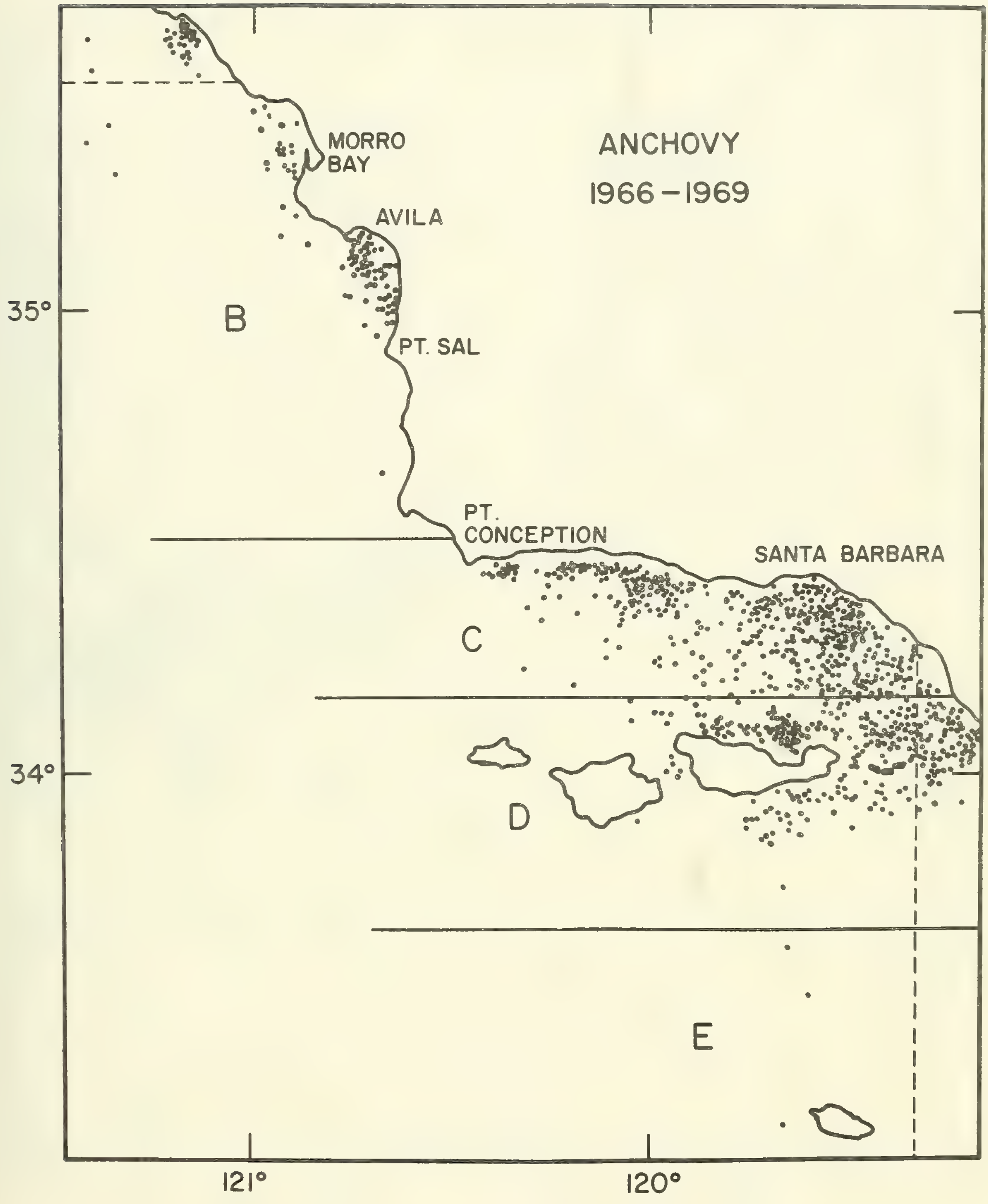


Figure 5.—Northern anchovy—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1966-69.

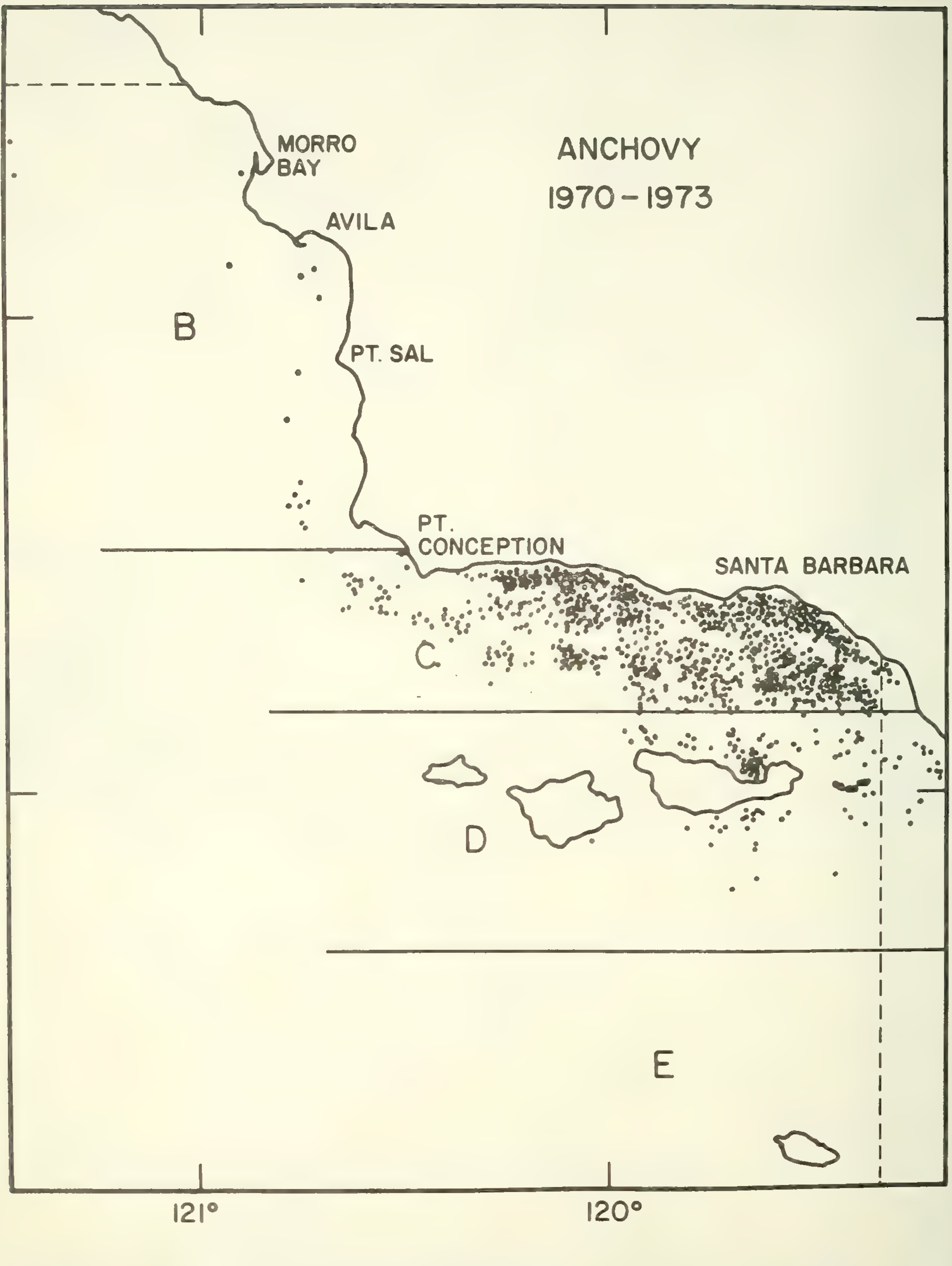


Figure 6.—Northern anchovy—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1970-73.

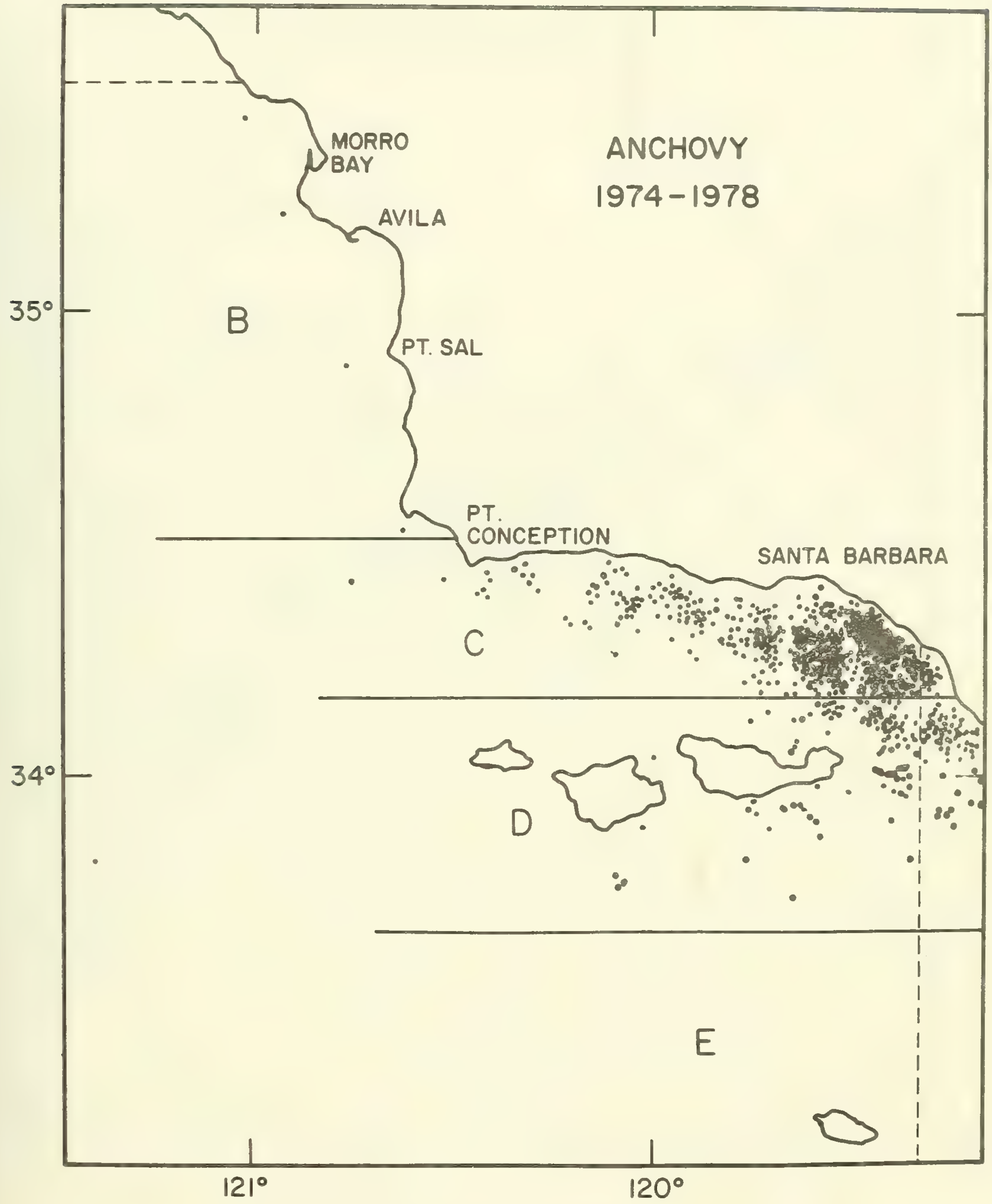


Figure 7.—Northern anchovy—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1974-78.

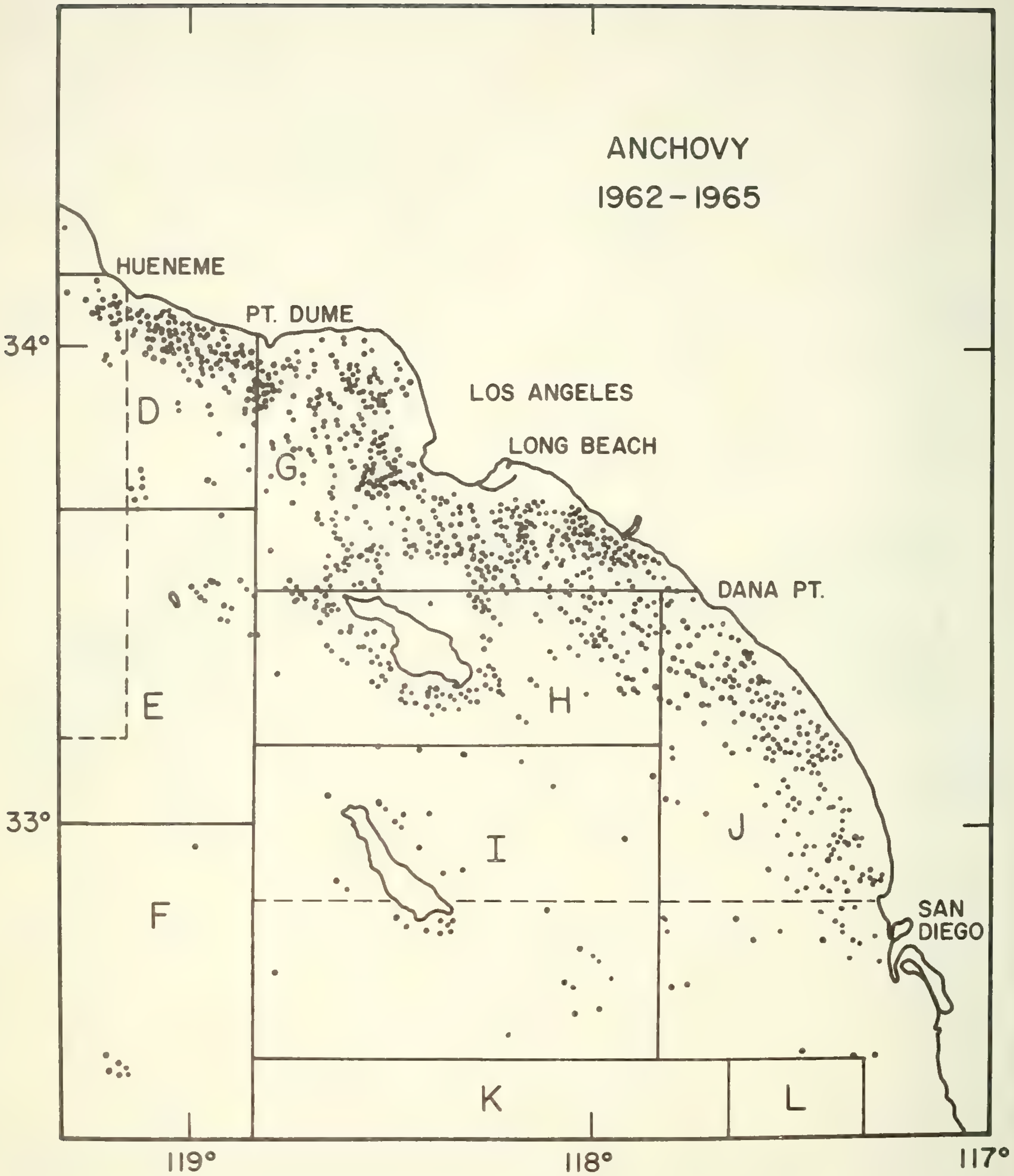


Figure 8.—Northern anchovy—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1962-65.

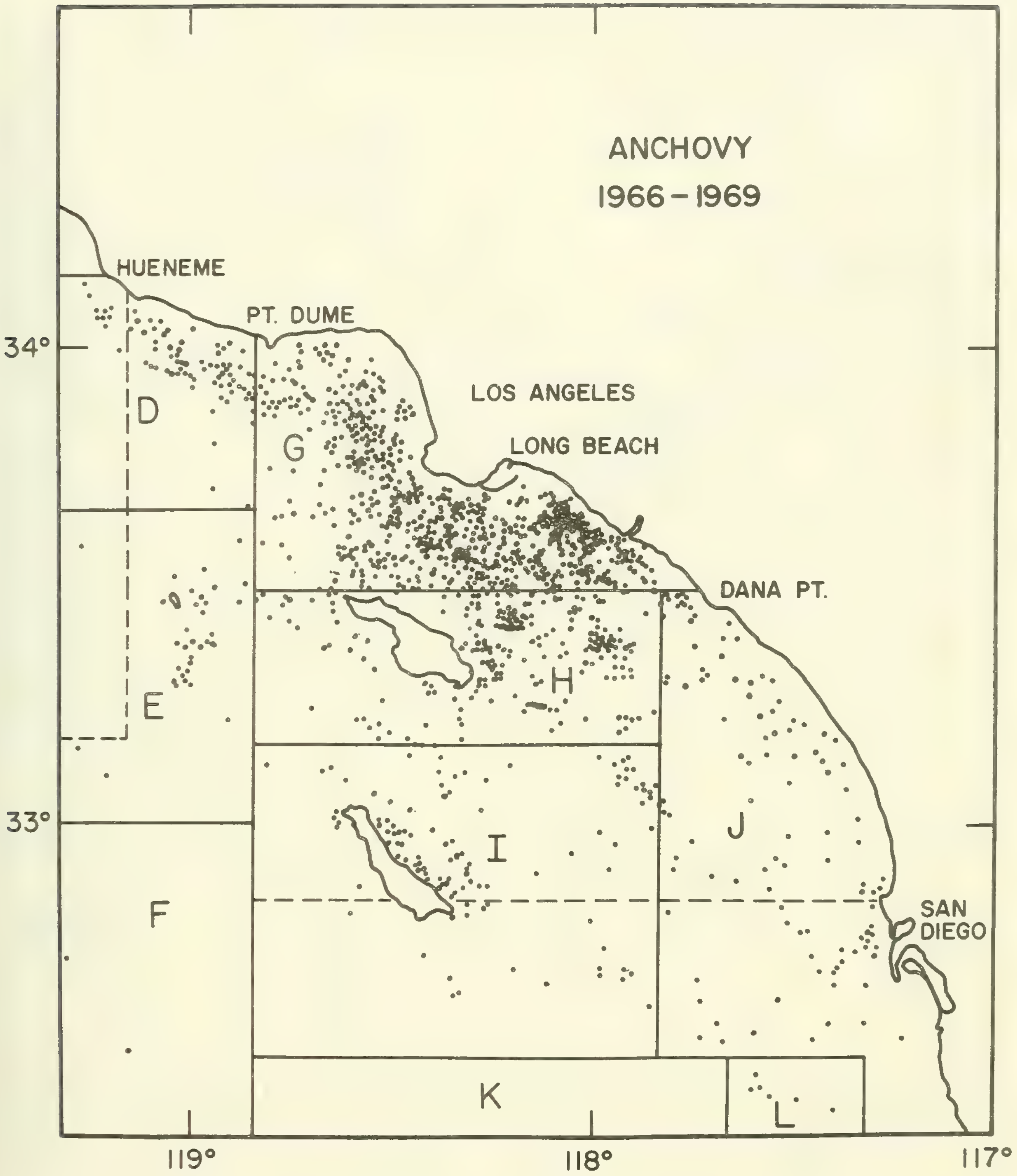


Figure 9.—Northern anchovy—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1966-69.

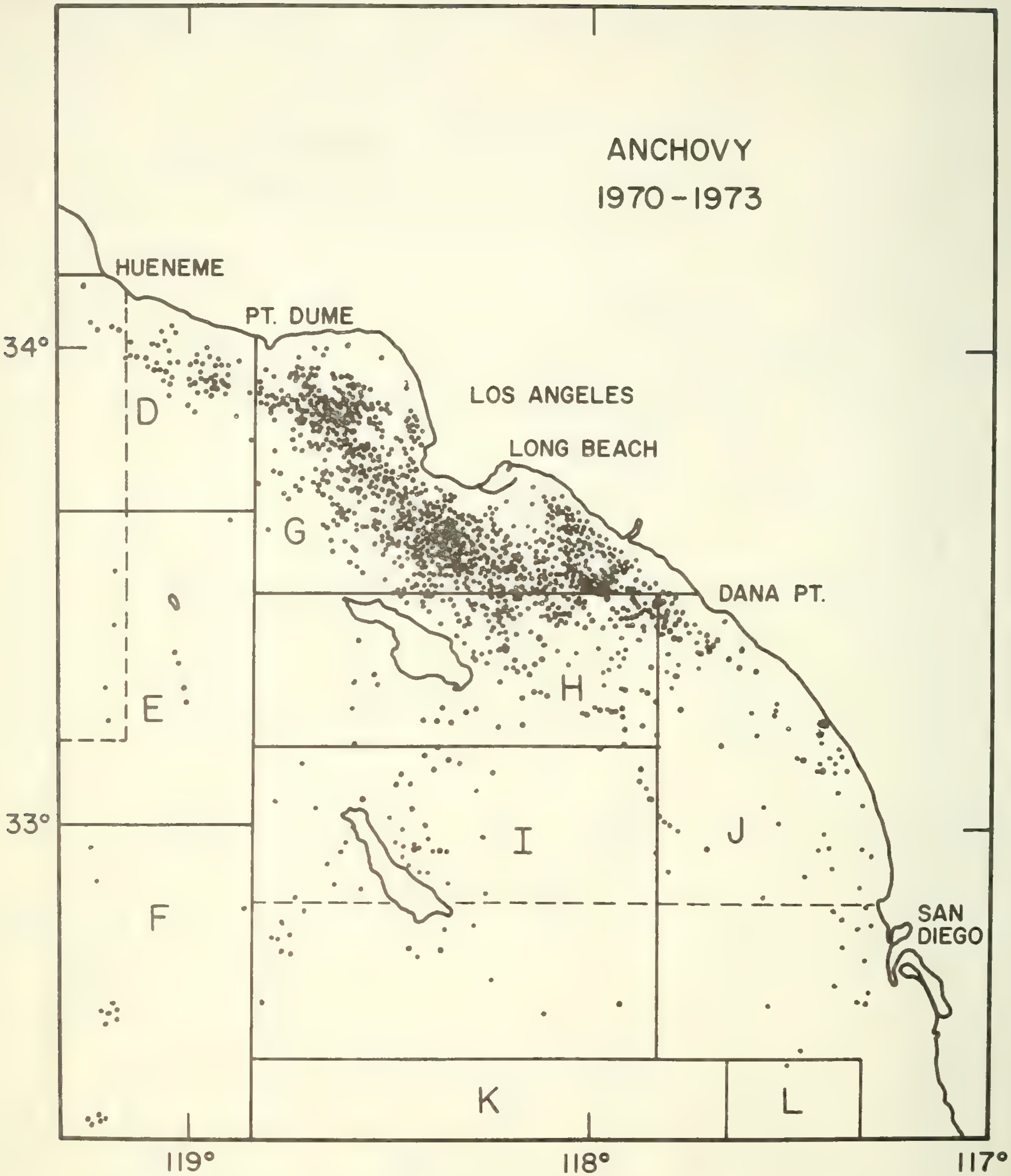


Figure 10.—Northern anchovy—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1970-73.

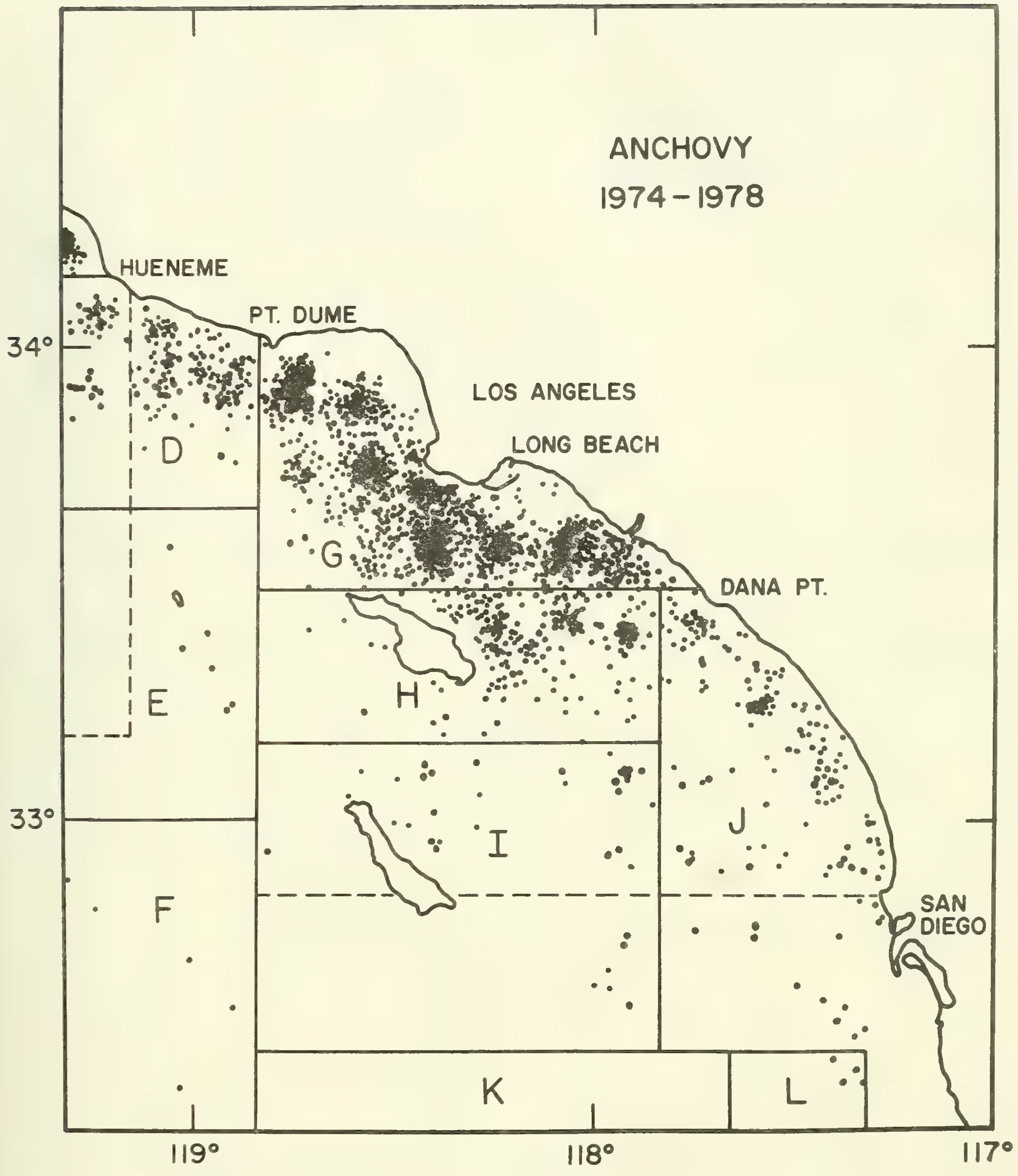


Figure 11.—Northern anchovy—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1974-78.

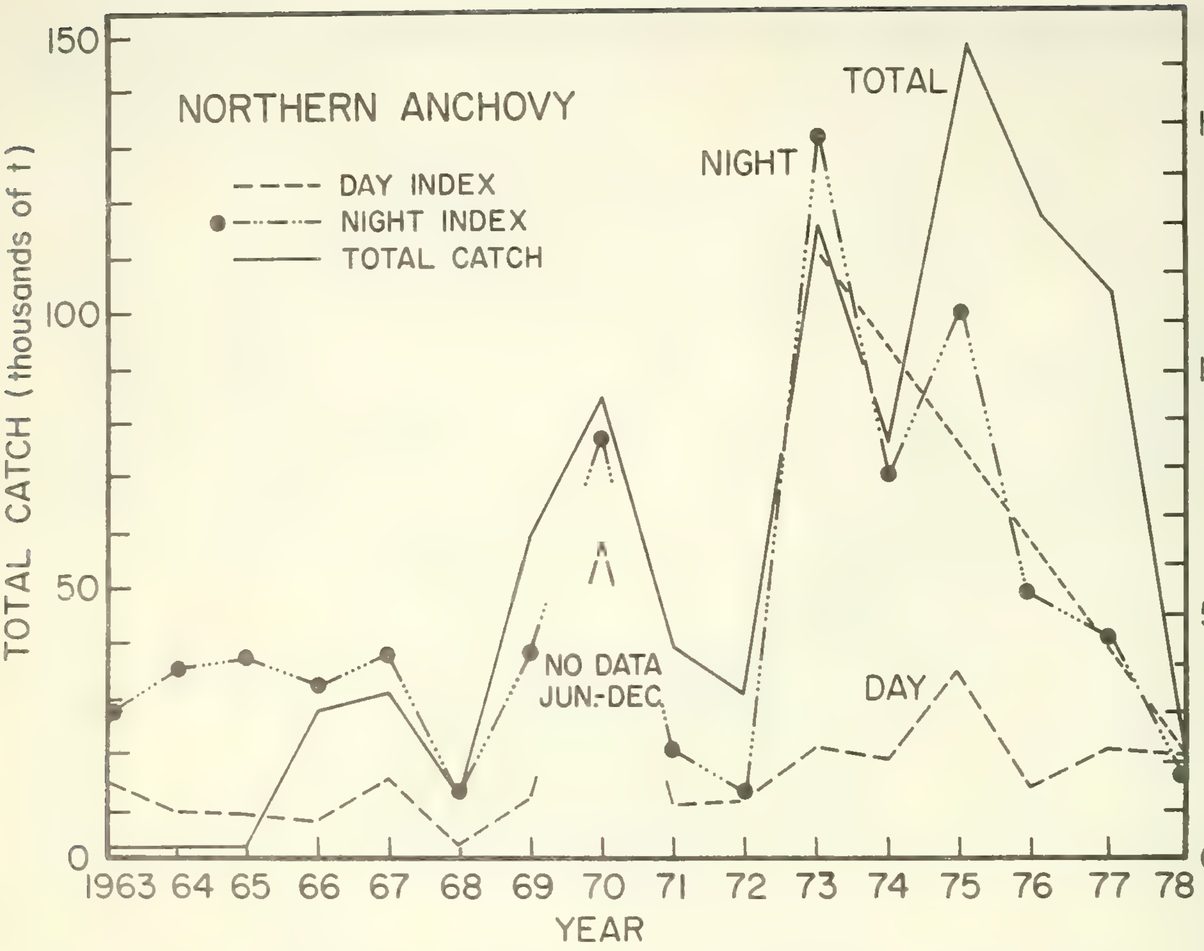


Figure 12.—Northern anchovy index values for day and night observations in arbitrary units and total California catch.

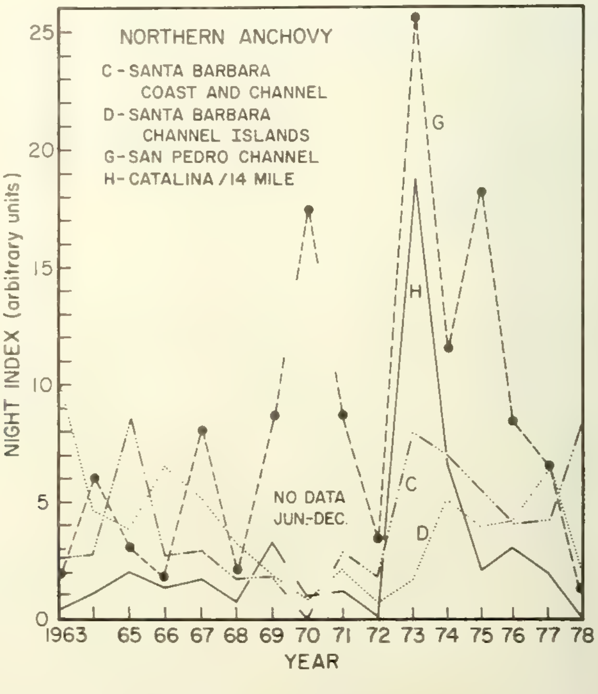


Figure 13.—Northern anchovy night index values in arbitrary units for the major fishing areas.

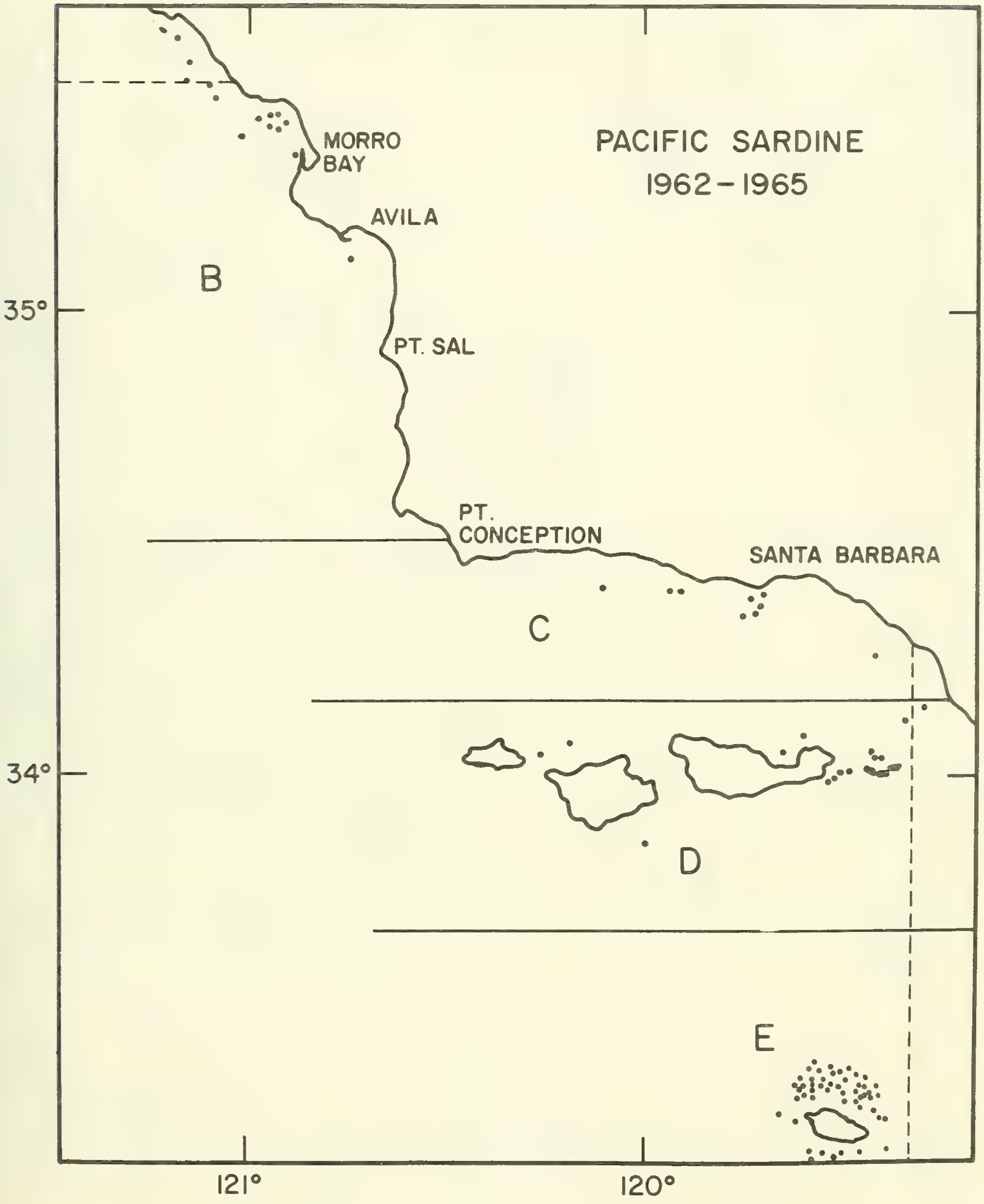


Figure 14.—Pacific sardine—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1962-65.

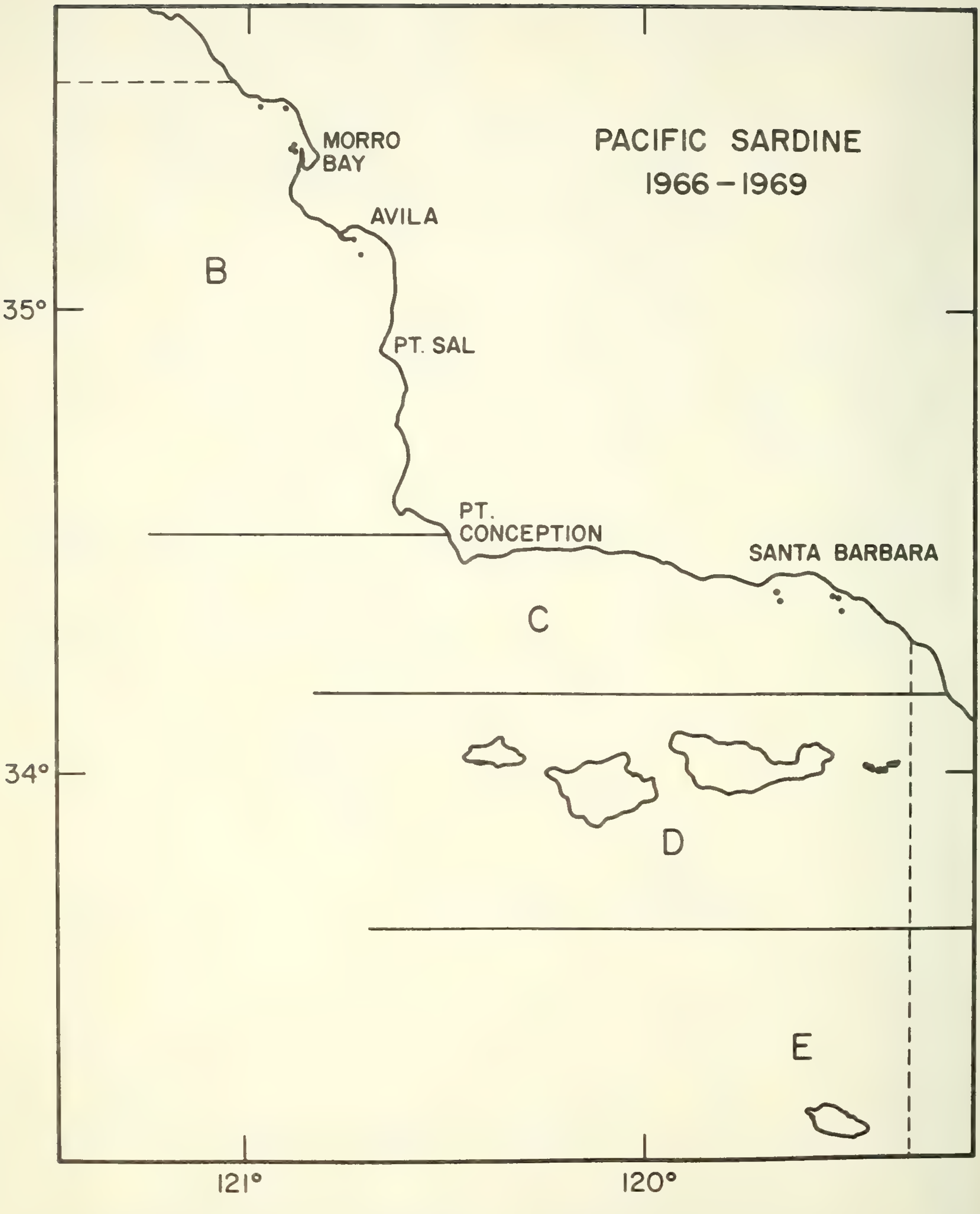


Figure 15.—Pacific sardine—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1966-69.

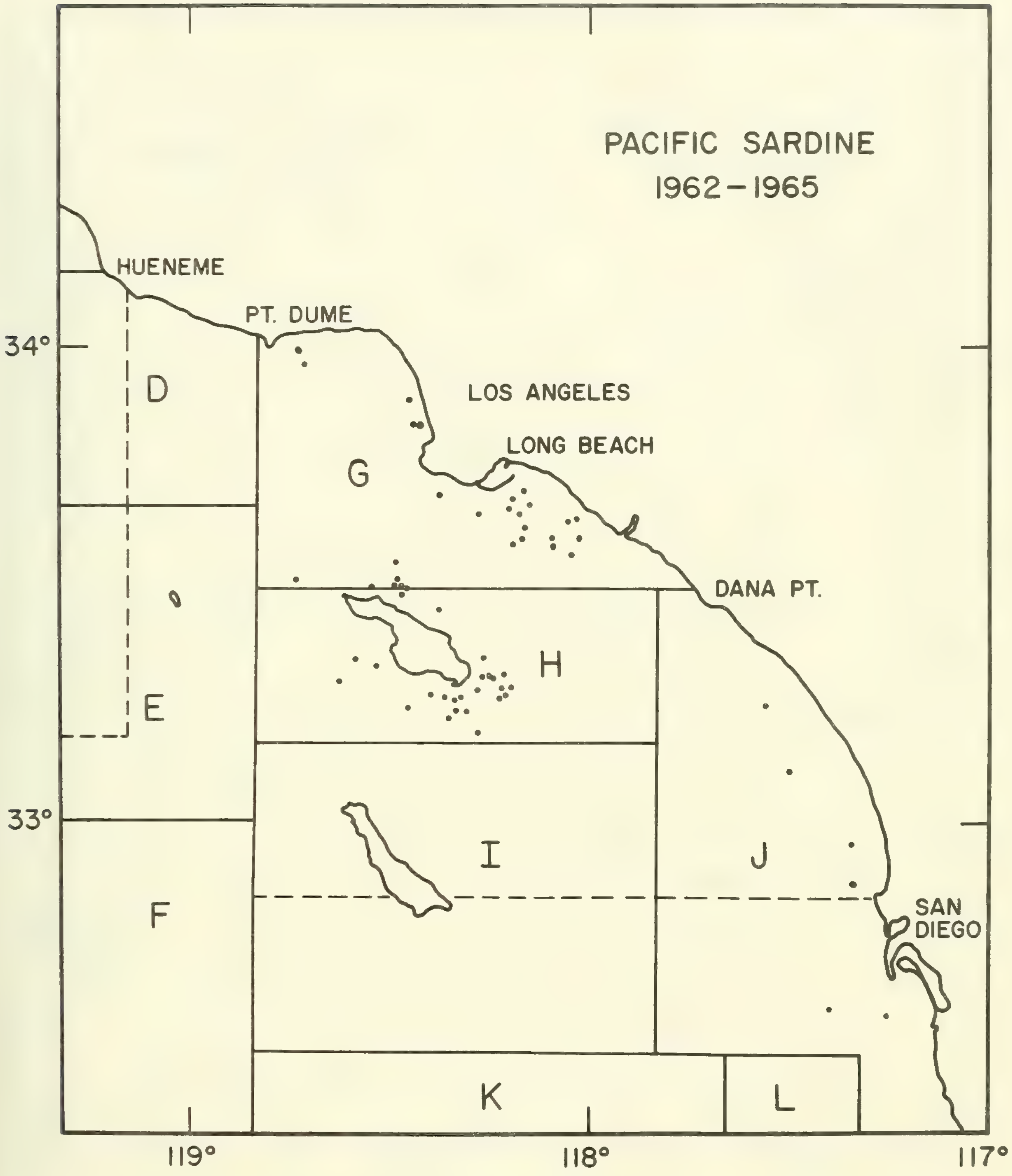


Figure 16.—Pacific sardine—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1962-65.

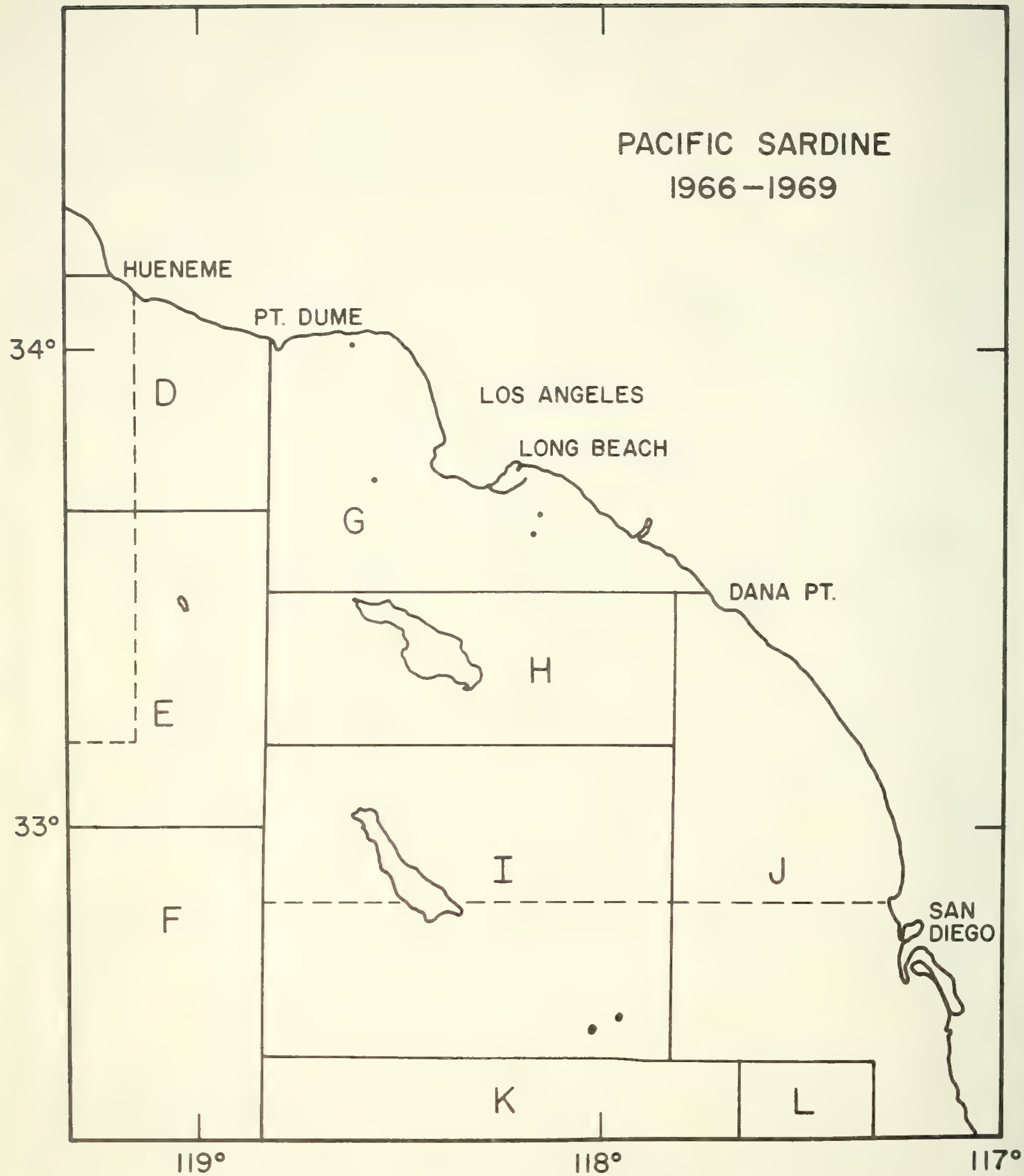


Figure 17.—Pacific sardine—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1966-69.

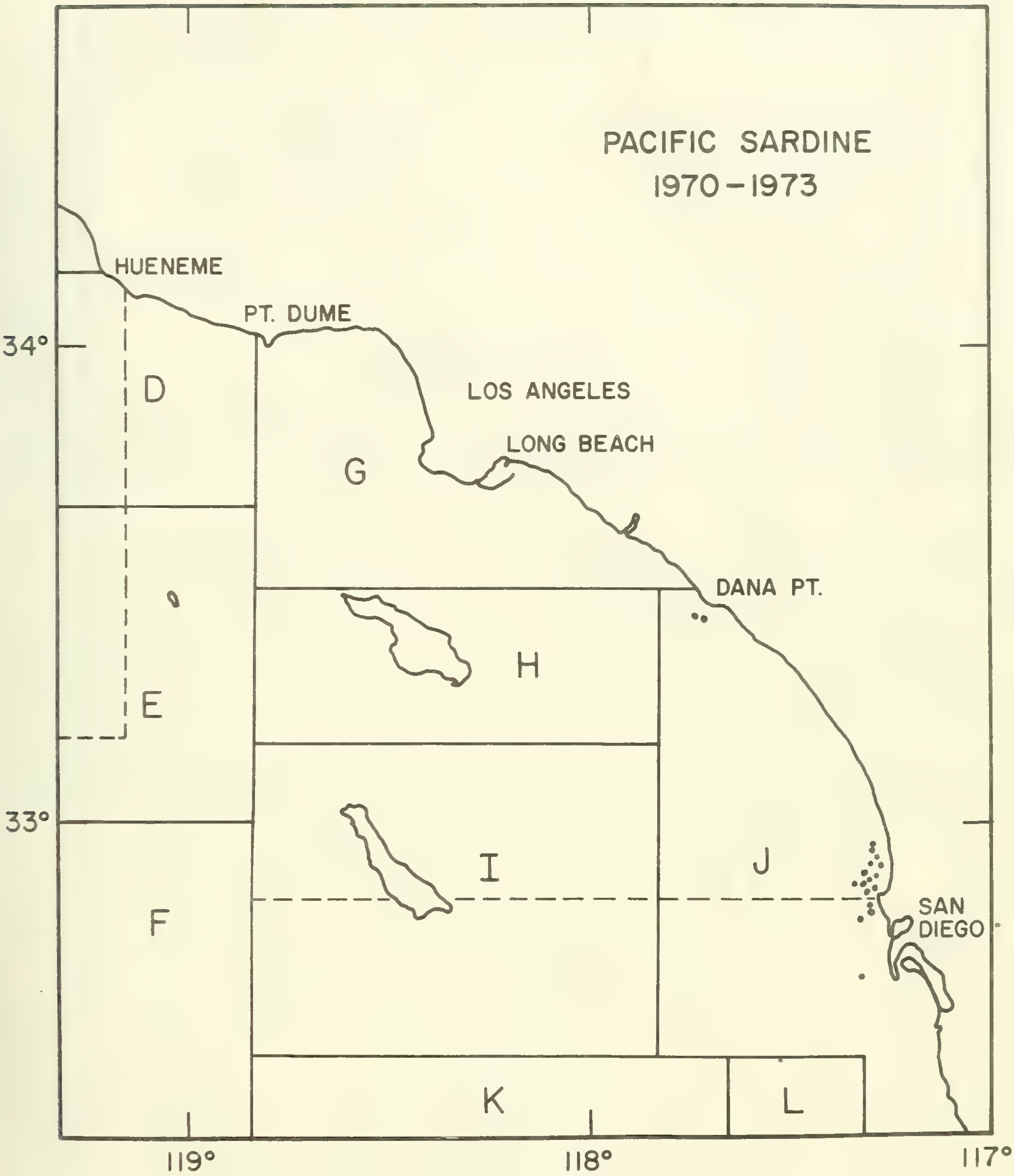


Figure 18.—Pacific sardine—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1970-73.

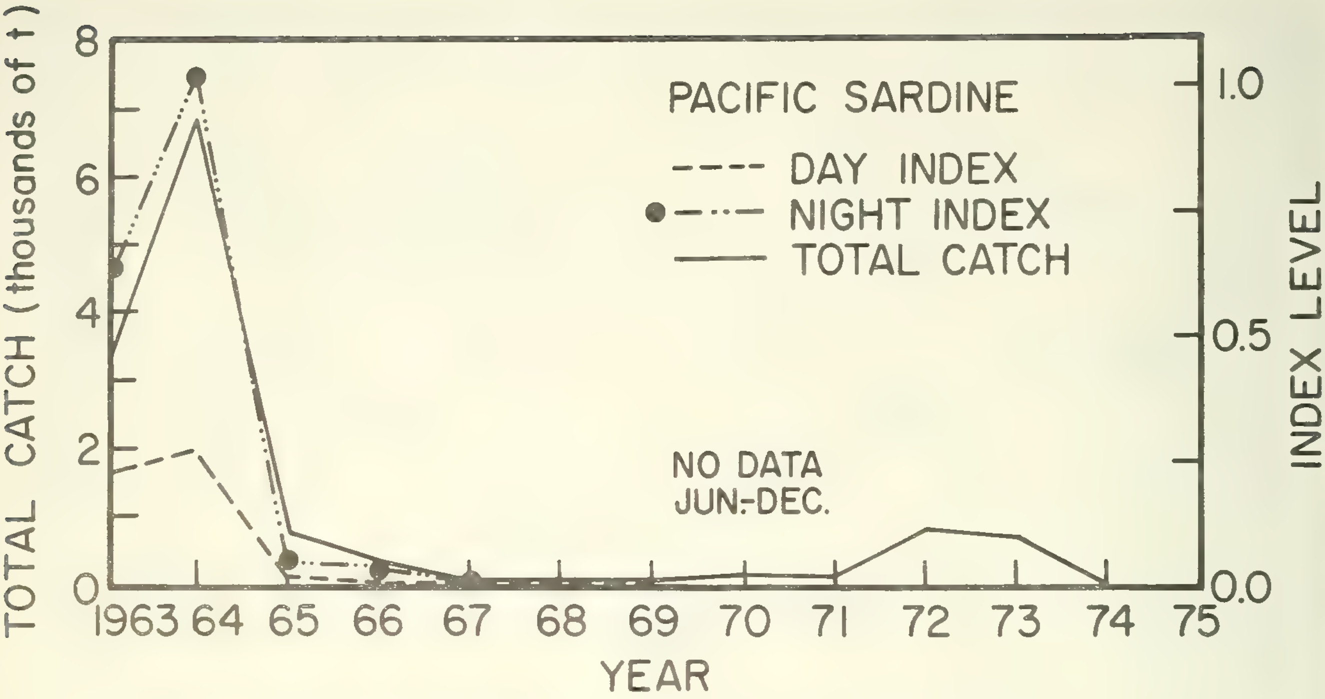


Figure 19. –Pacific sardine index values in arbitrary units for day and night observations and total California catch.

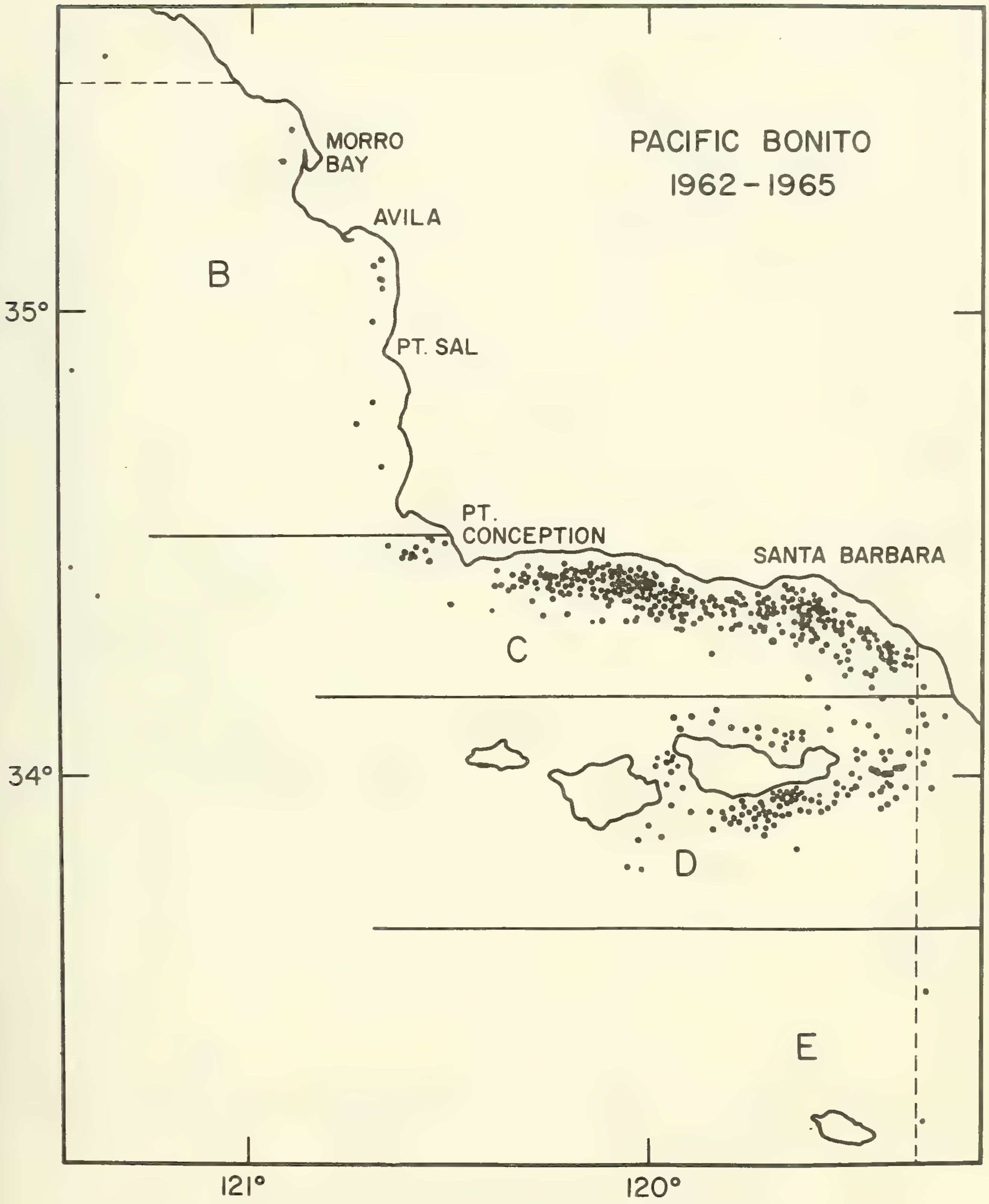


Figure 20.—Pacific bonito—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1962-65.

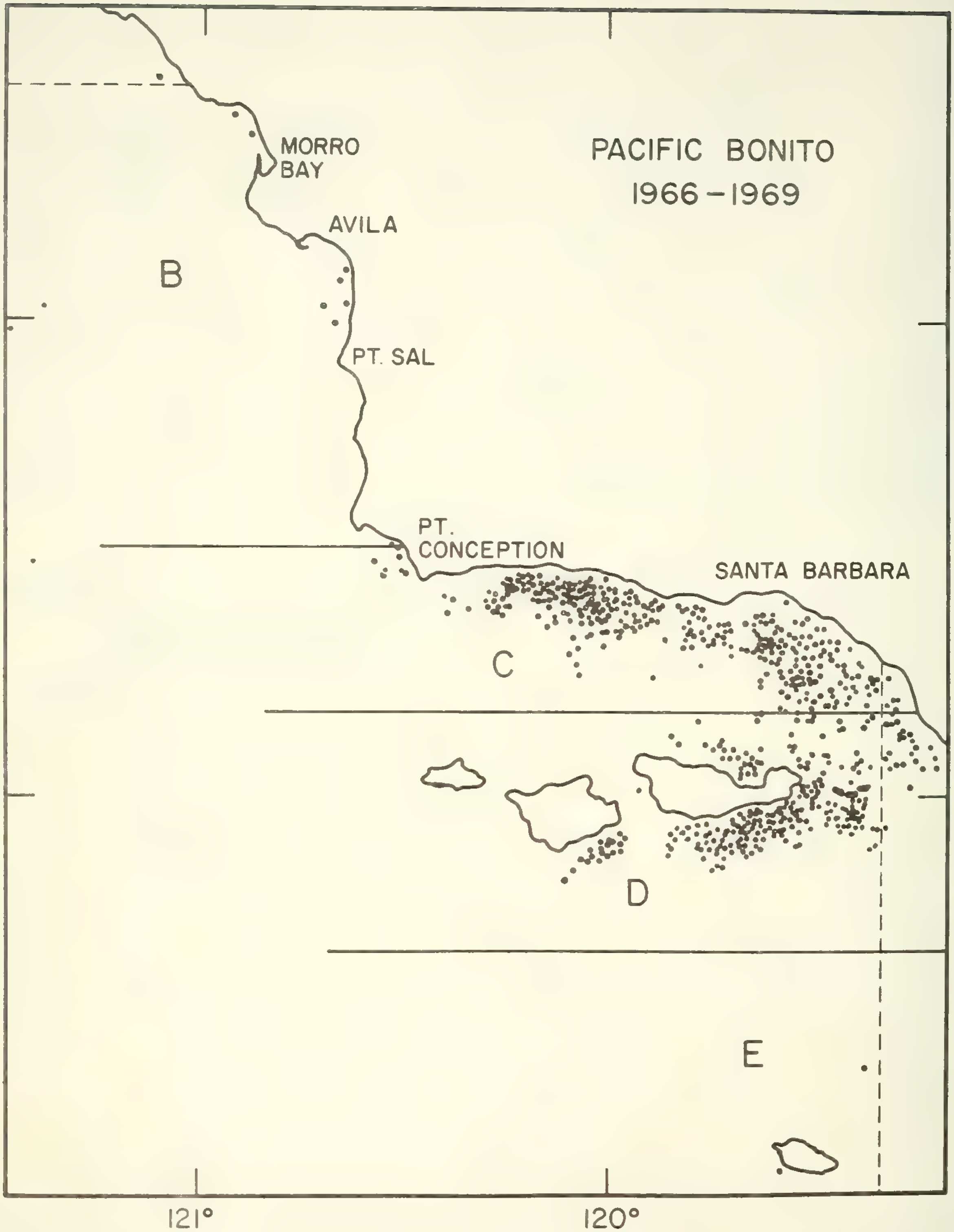


Figure 21.—Pacific bonito—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1966-69.

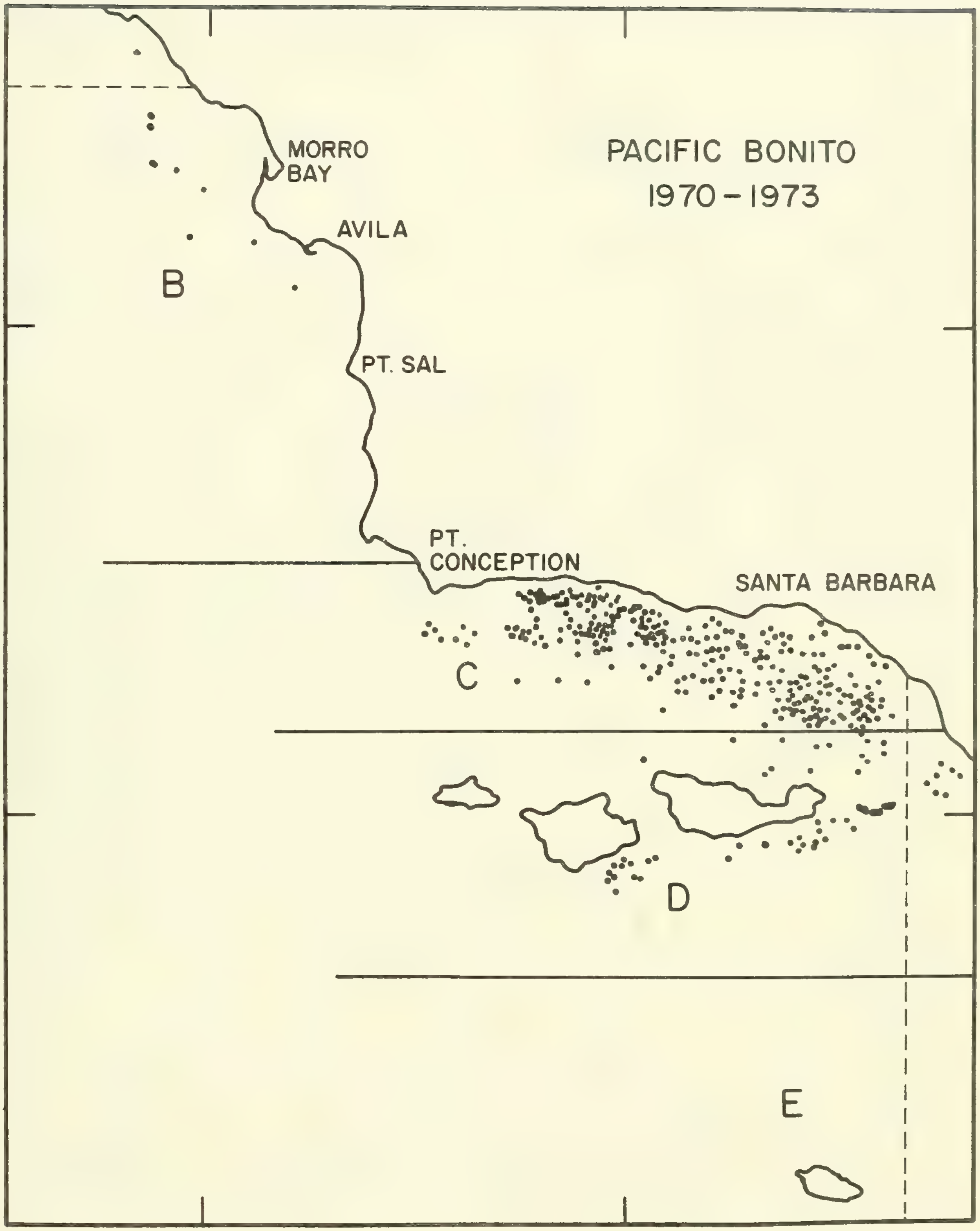


Figure 22.—Pacific bonito—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1970-73.

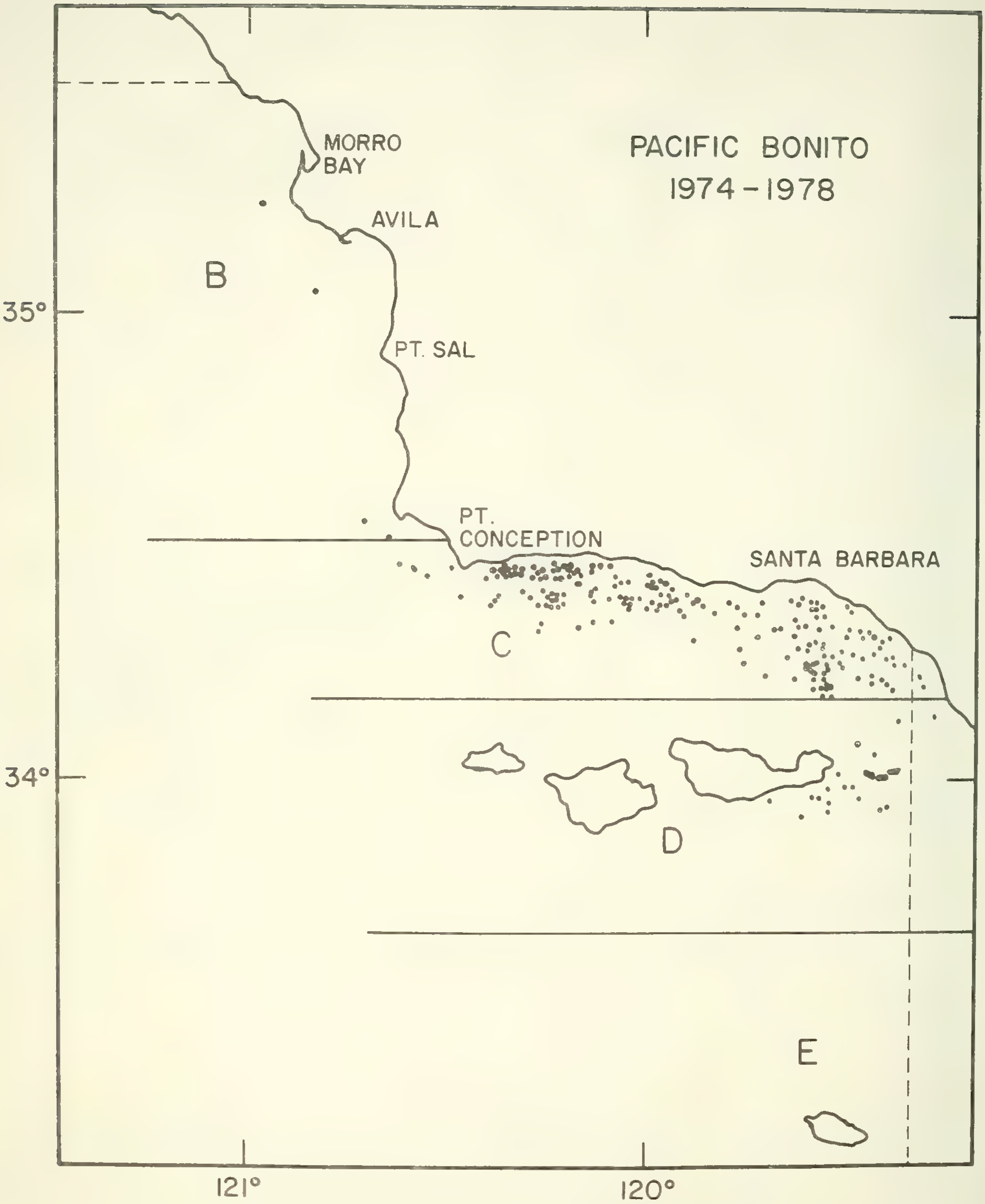


Figure 23.—Pacific bonito—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1974-78.

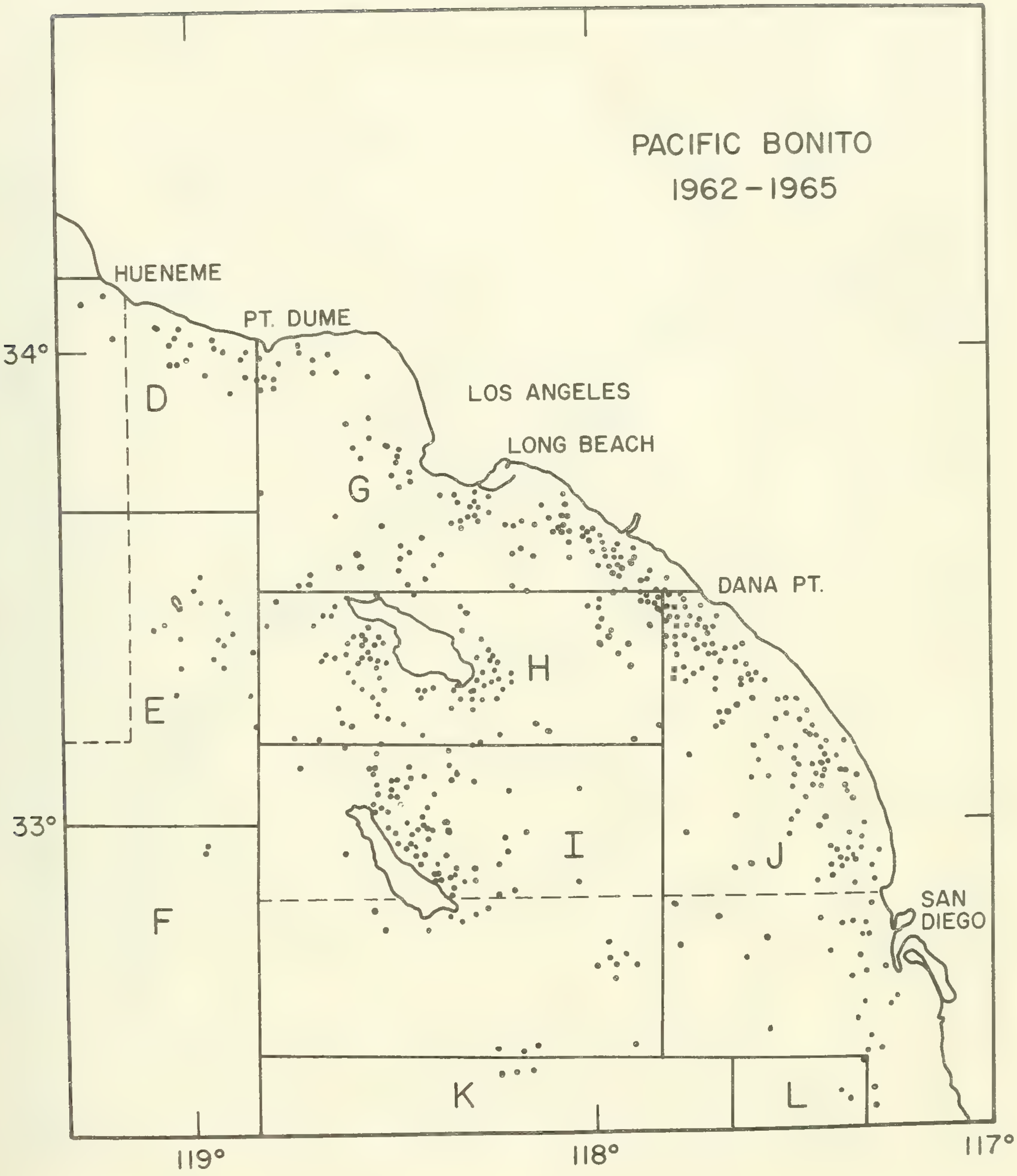


Figure 24.—Pacific bonito—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1962-65.

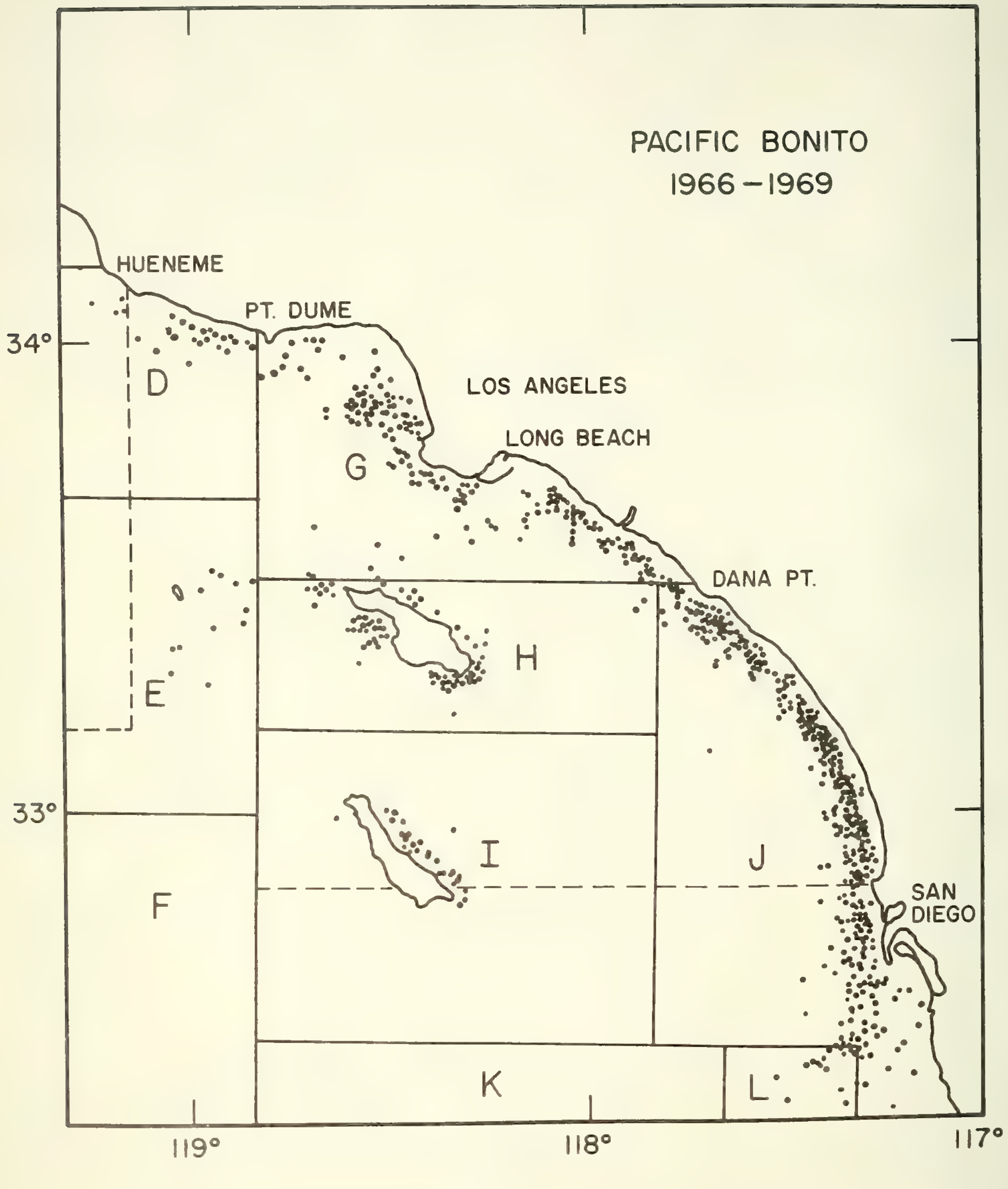


Figure 25.—Pacific bonito—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1966-69.

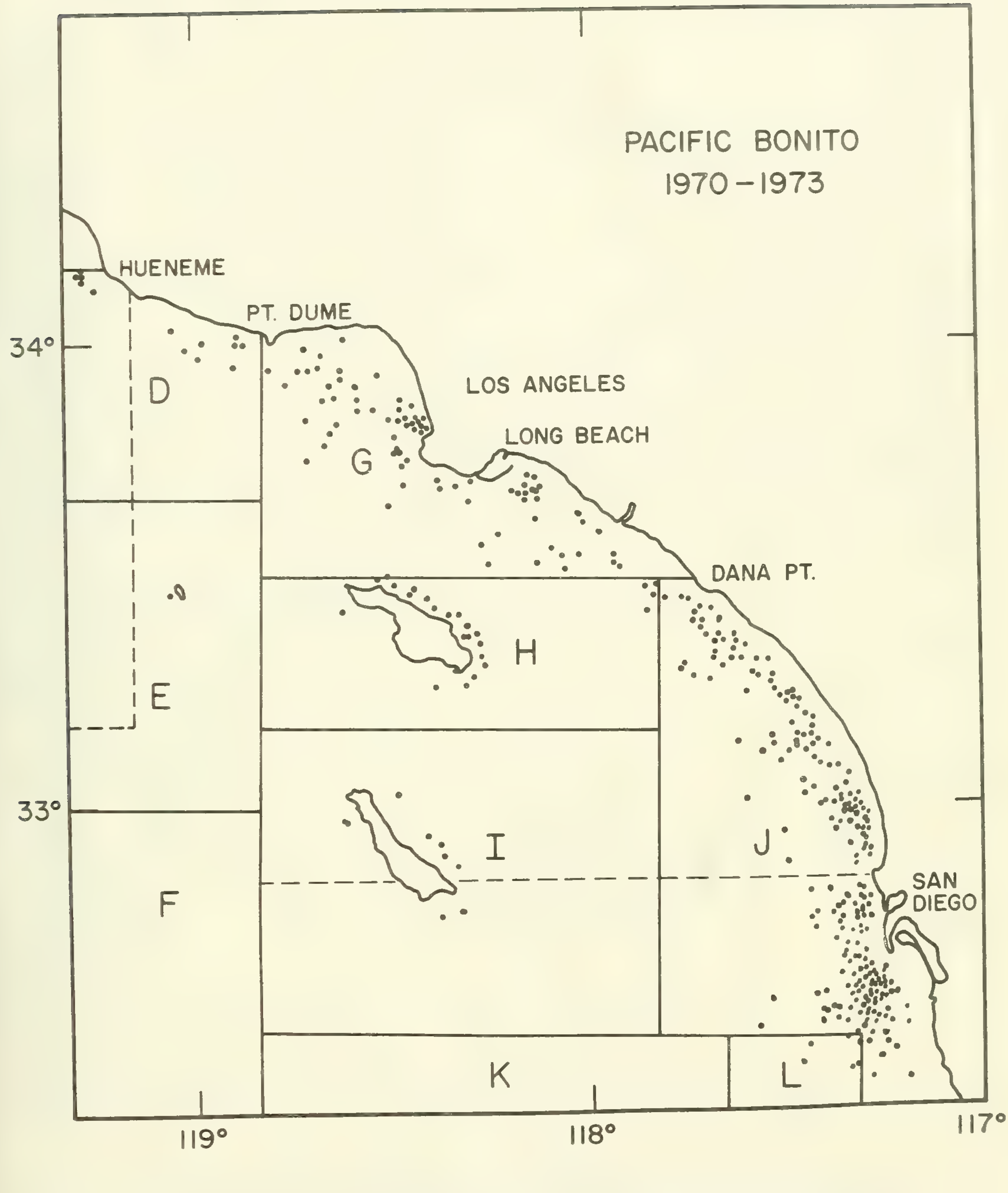


Figure 26.—Pacific bonito—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1970-73.

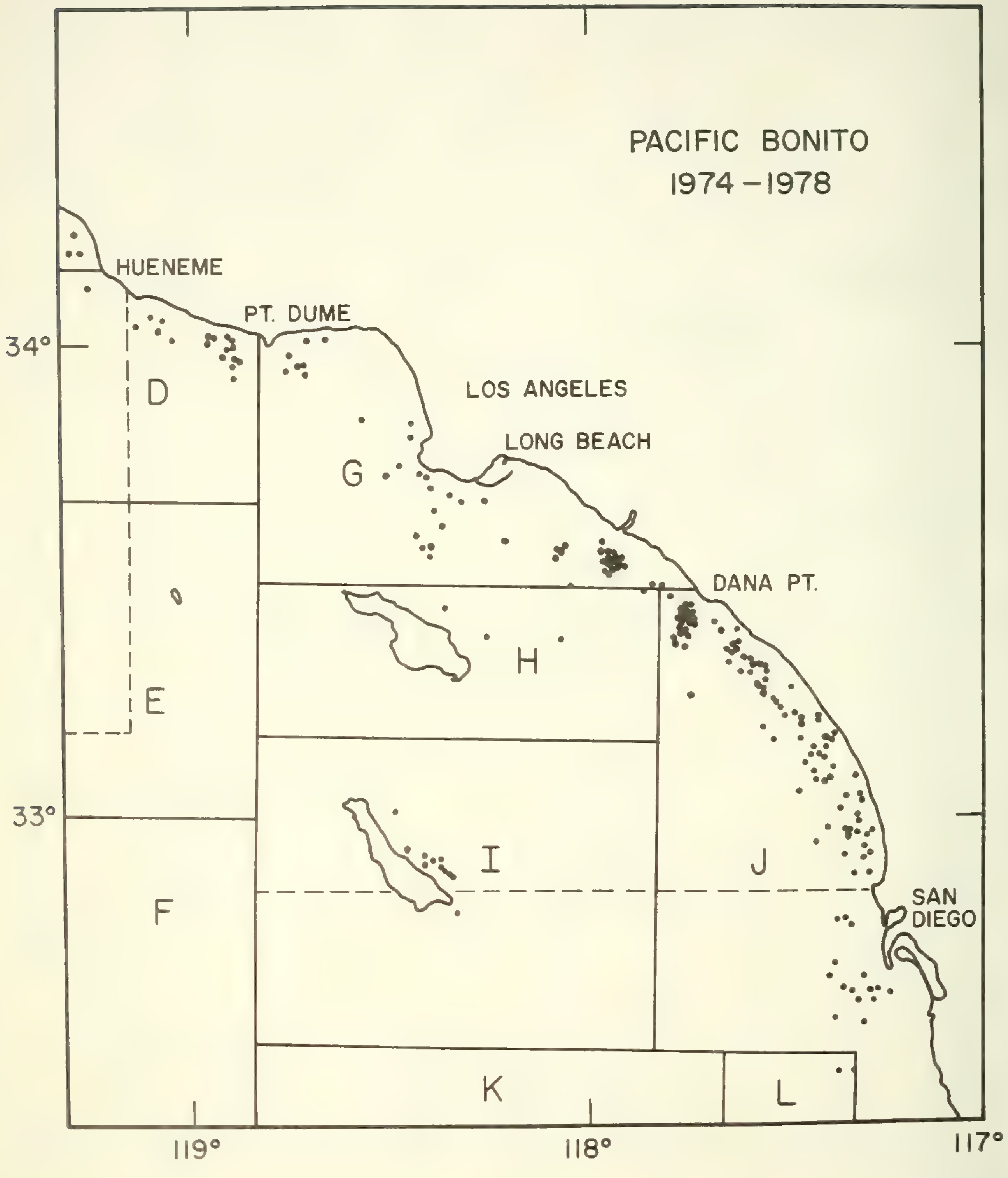


Figure 27.—Pacific bonito—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1974-78.

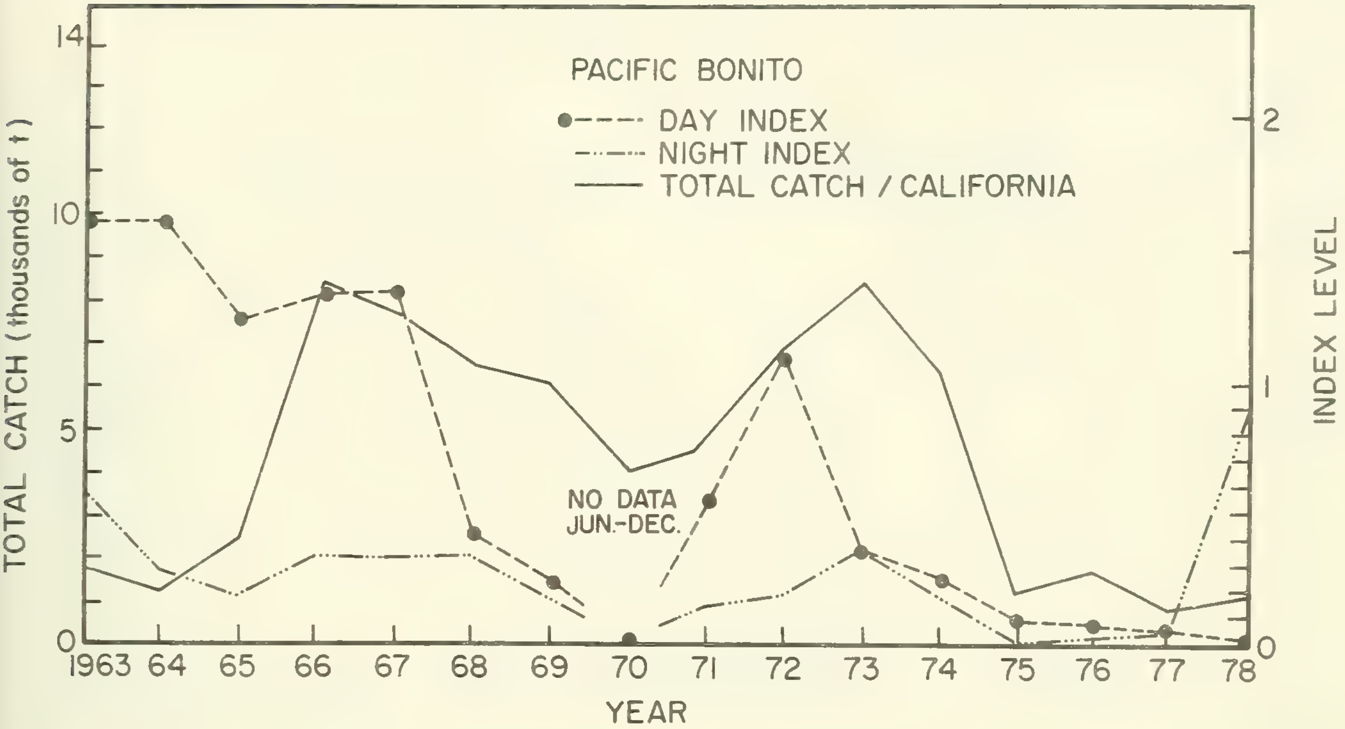


Figure 28.—Pacific bonito index values in arbitrary units for day and night observations and total California catch.

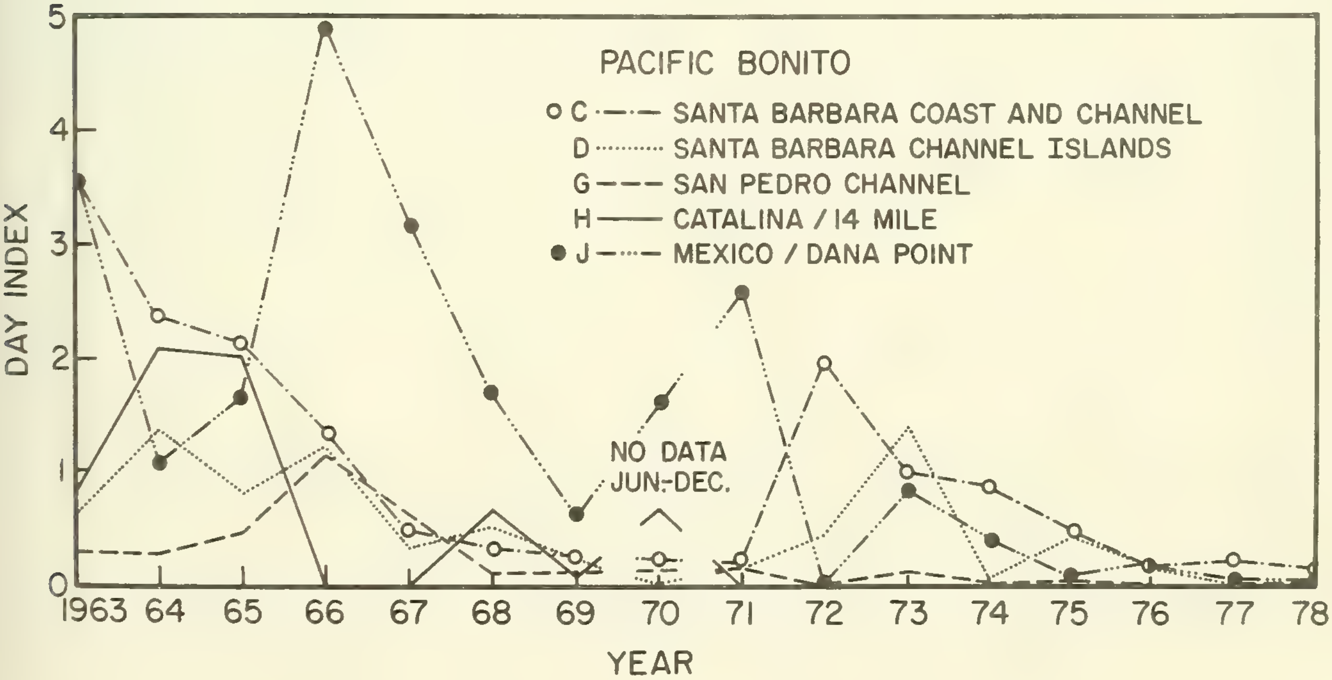


Figure 29.—Pacific bonito day index values in arbitrary units for the major fishing areas.

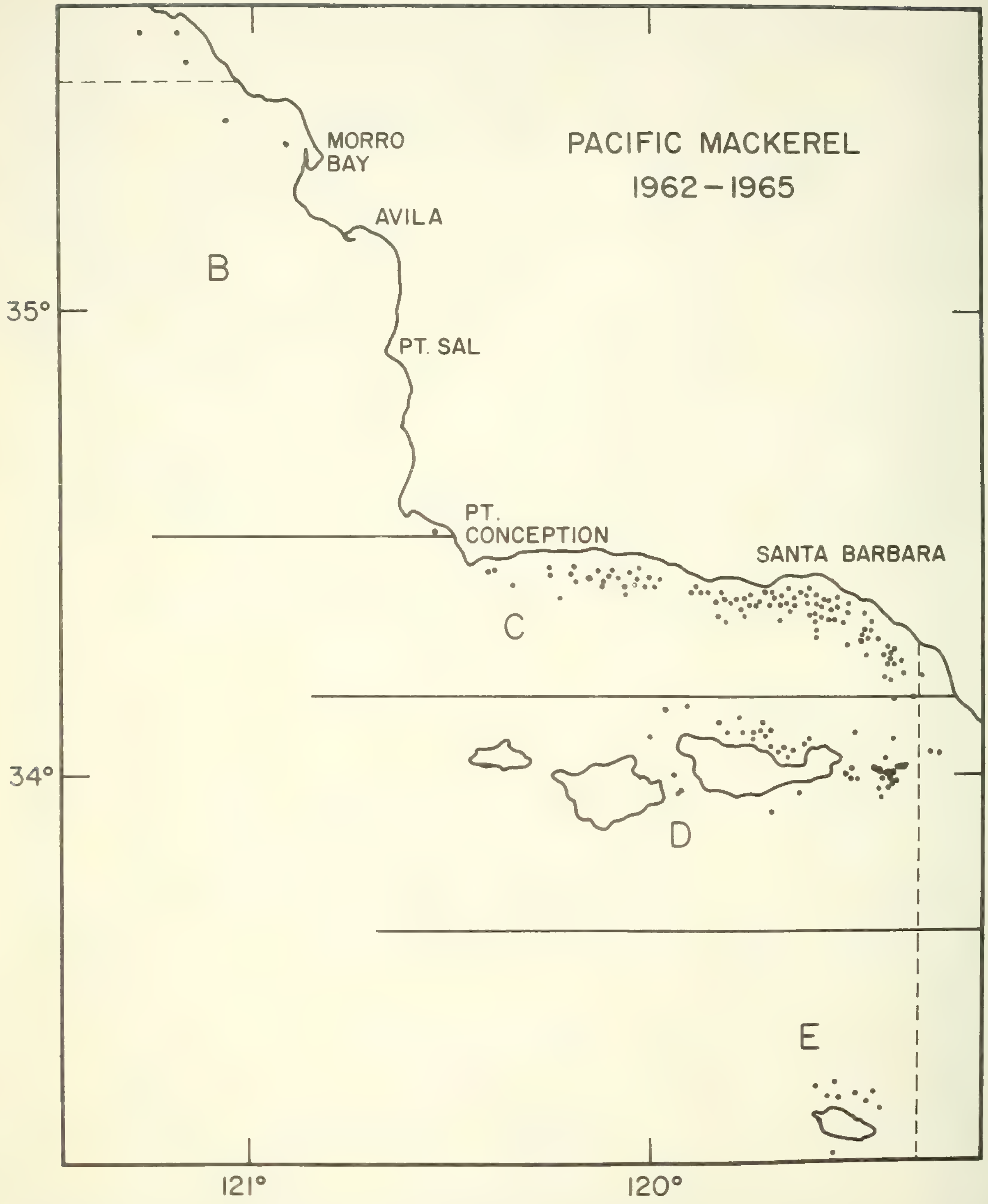


Figure 30.—Pacific mackerel—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1962-65.

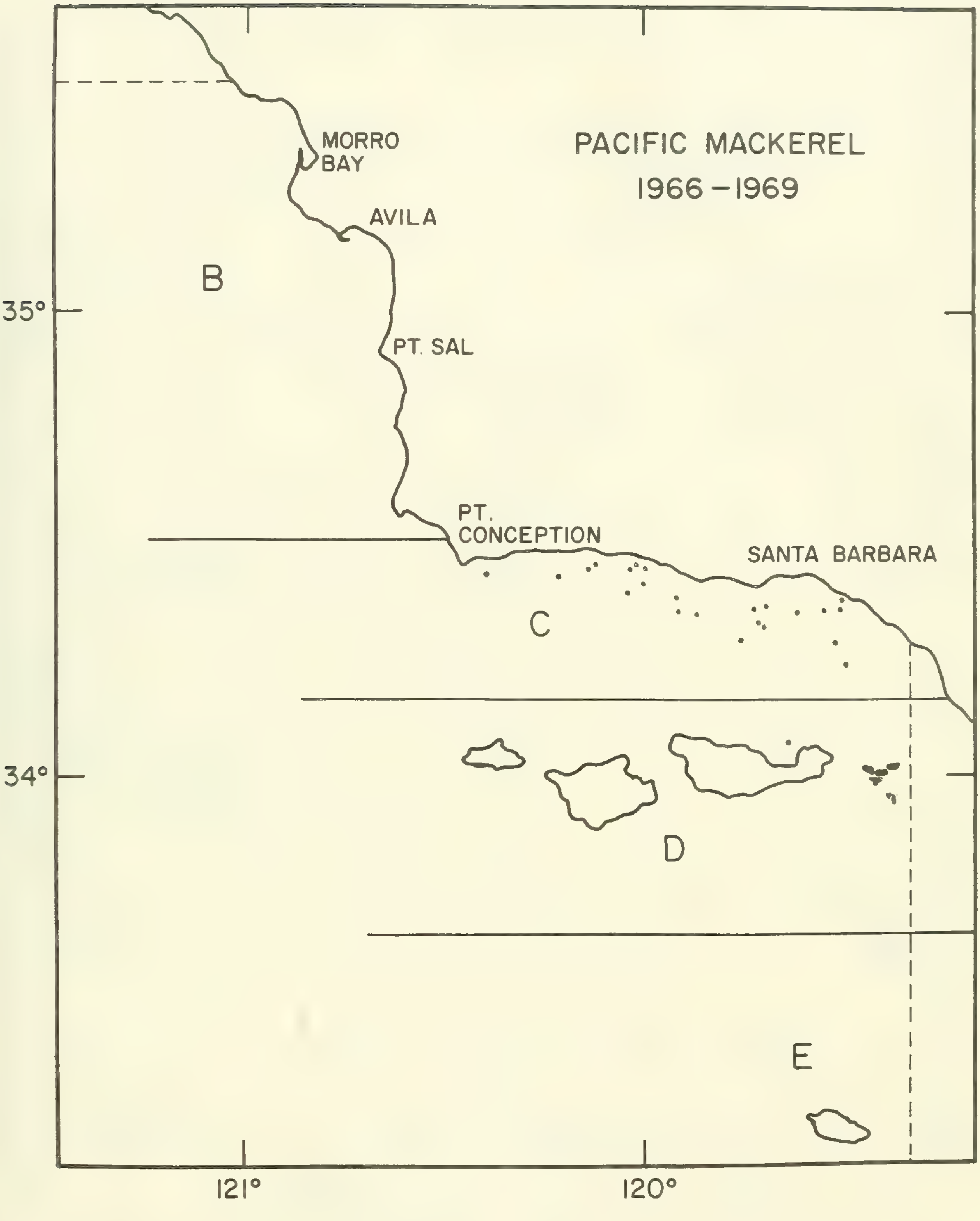


Figure 31.—Pacific mackerel—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1966-69.

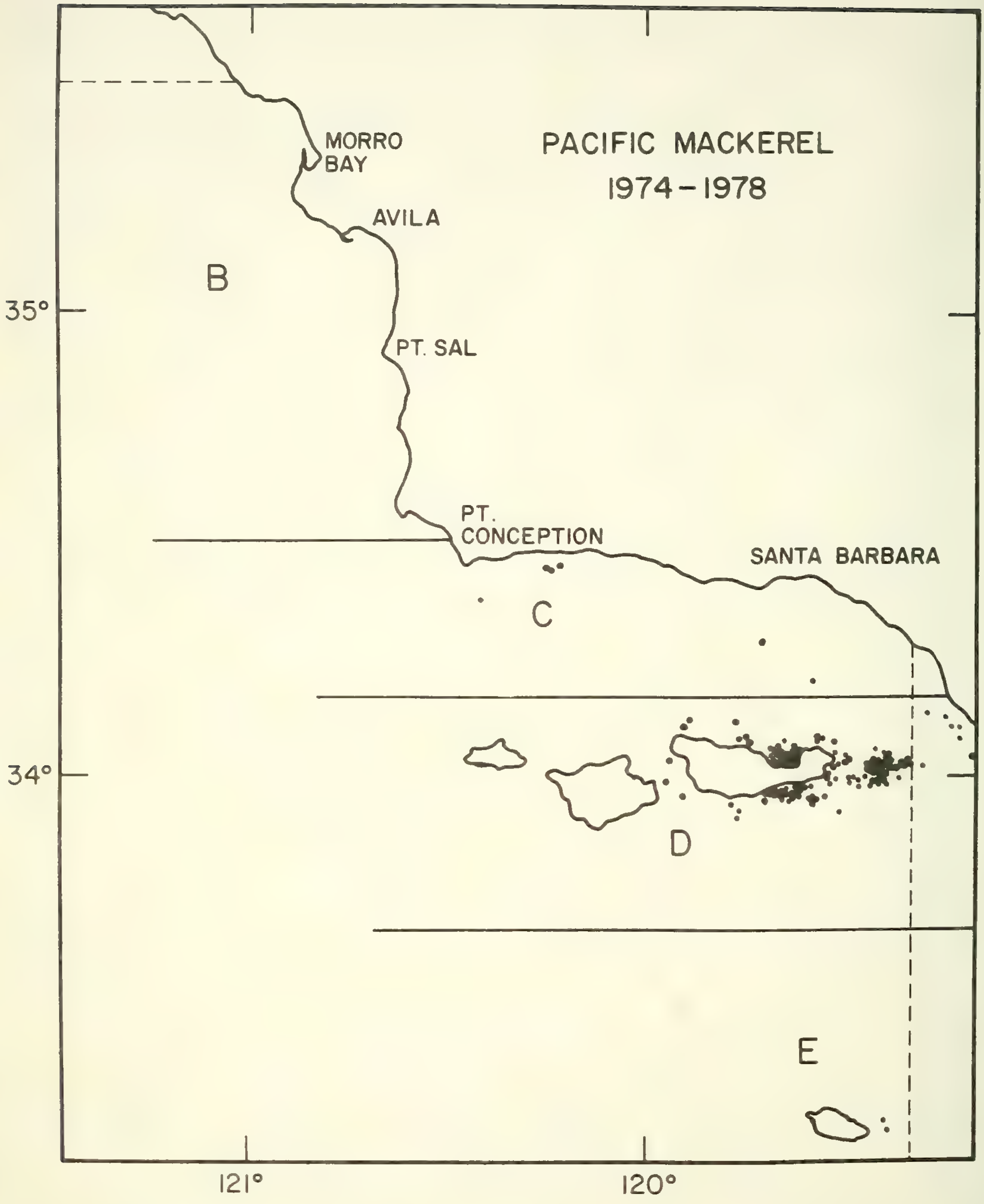


Figure 32.—Pacific mackerel—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1974-78.

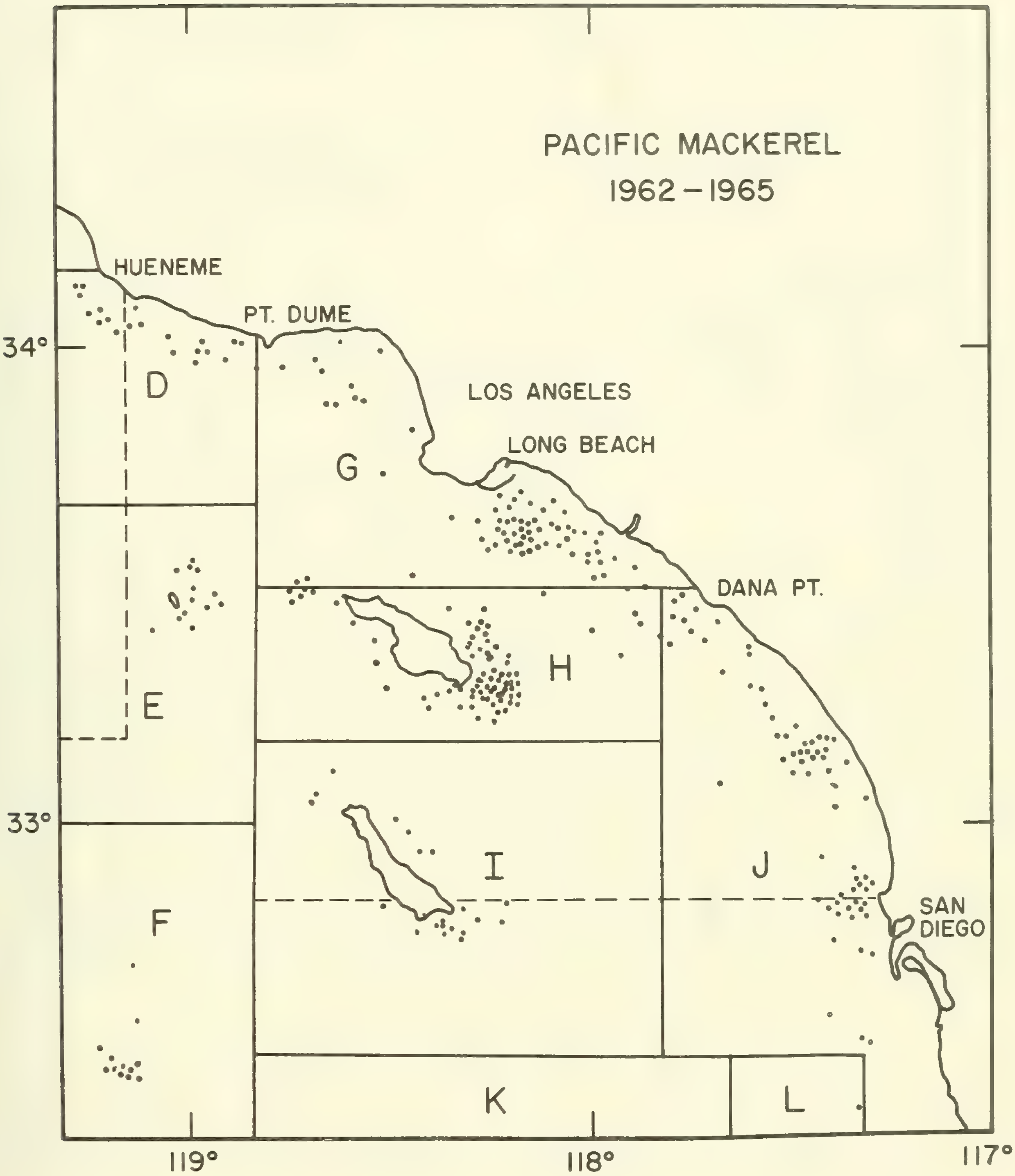


Figure 33.—Pacific mackerel—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1962-65.

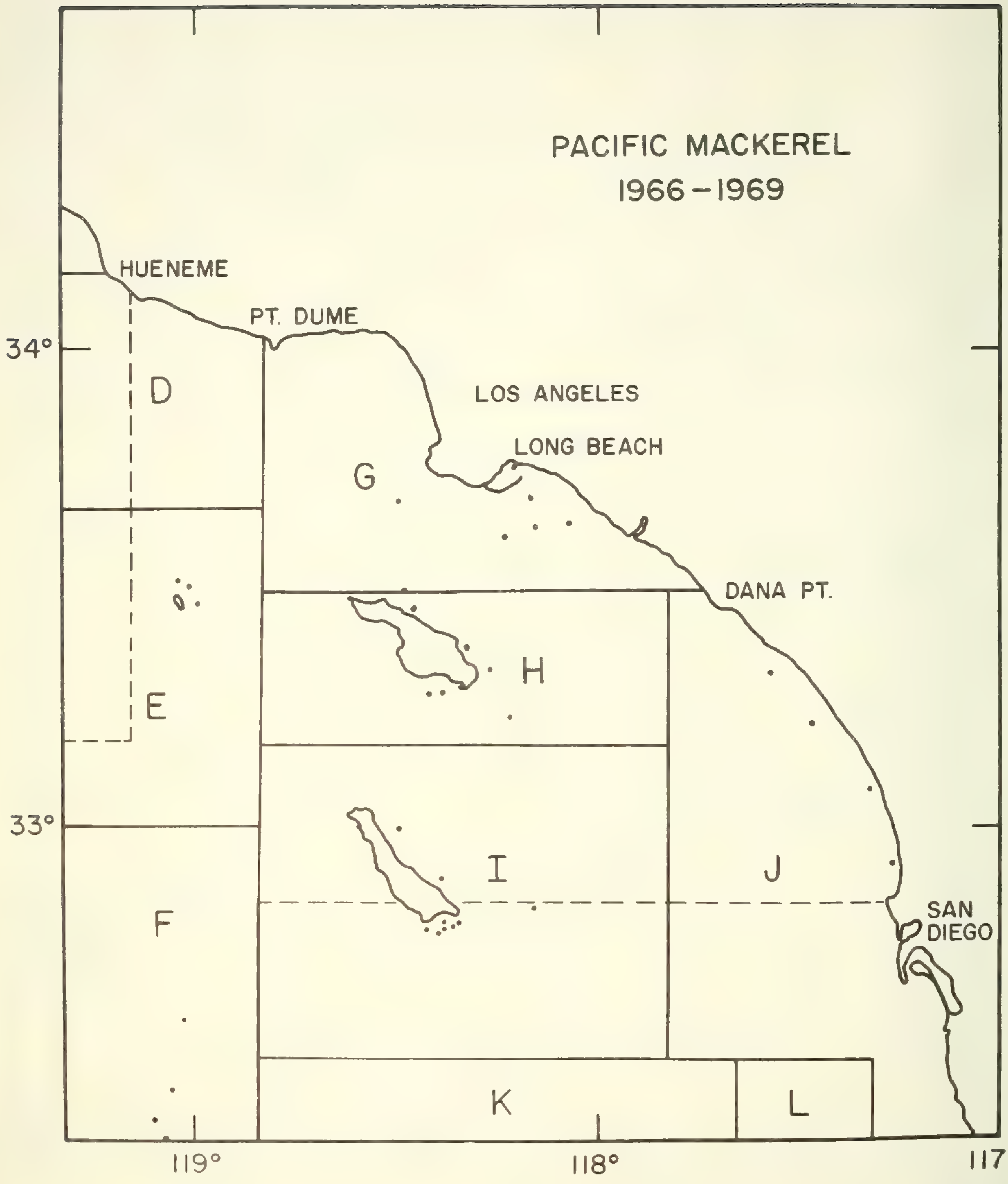


Figure 34.—Pacific mackerel—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1966-69.

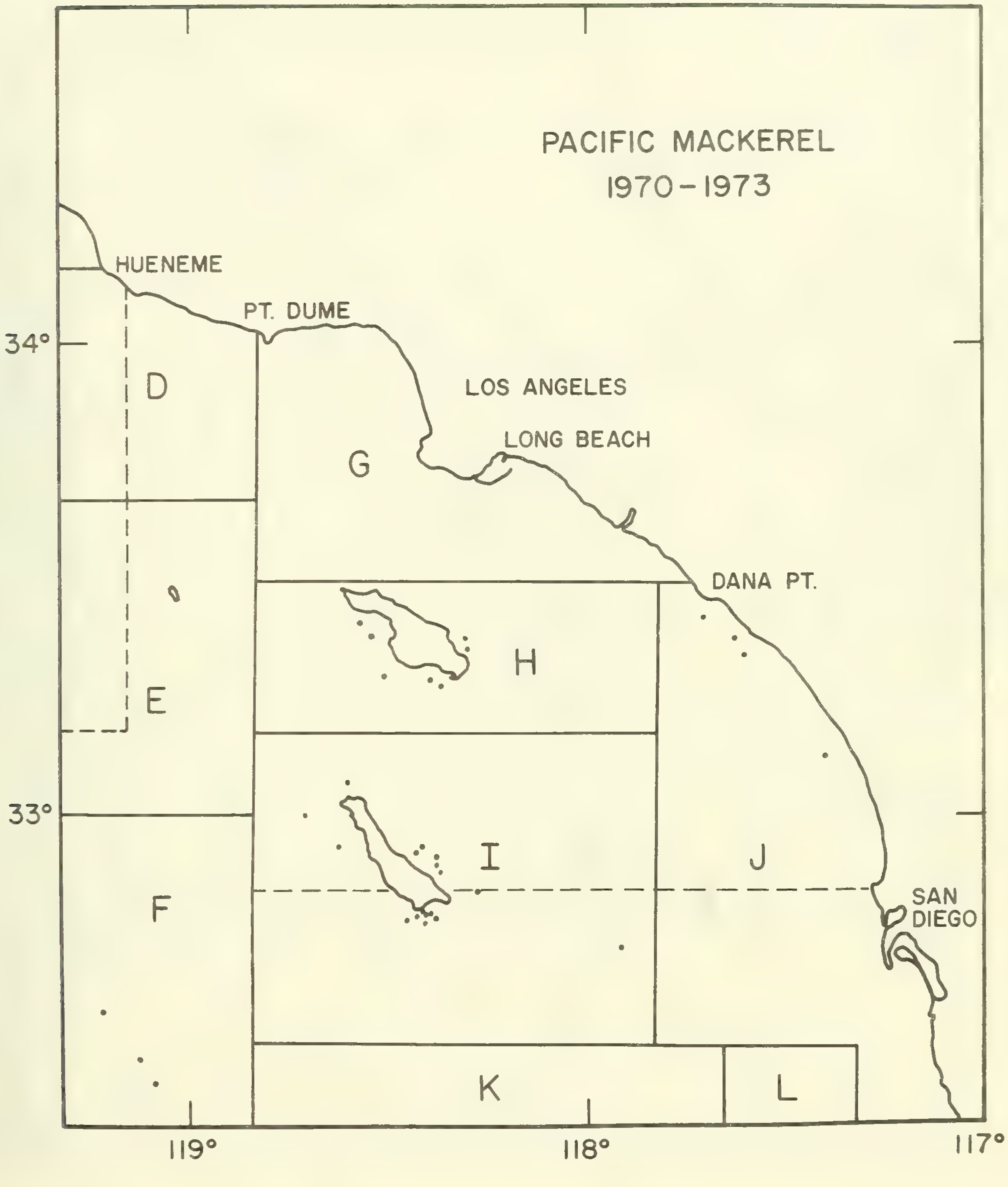


Figure 35.—Pacific mackerel—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1970-73.

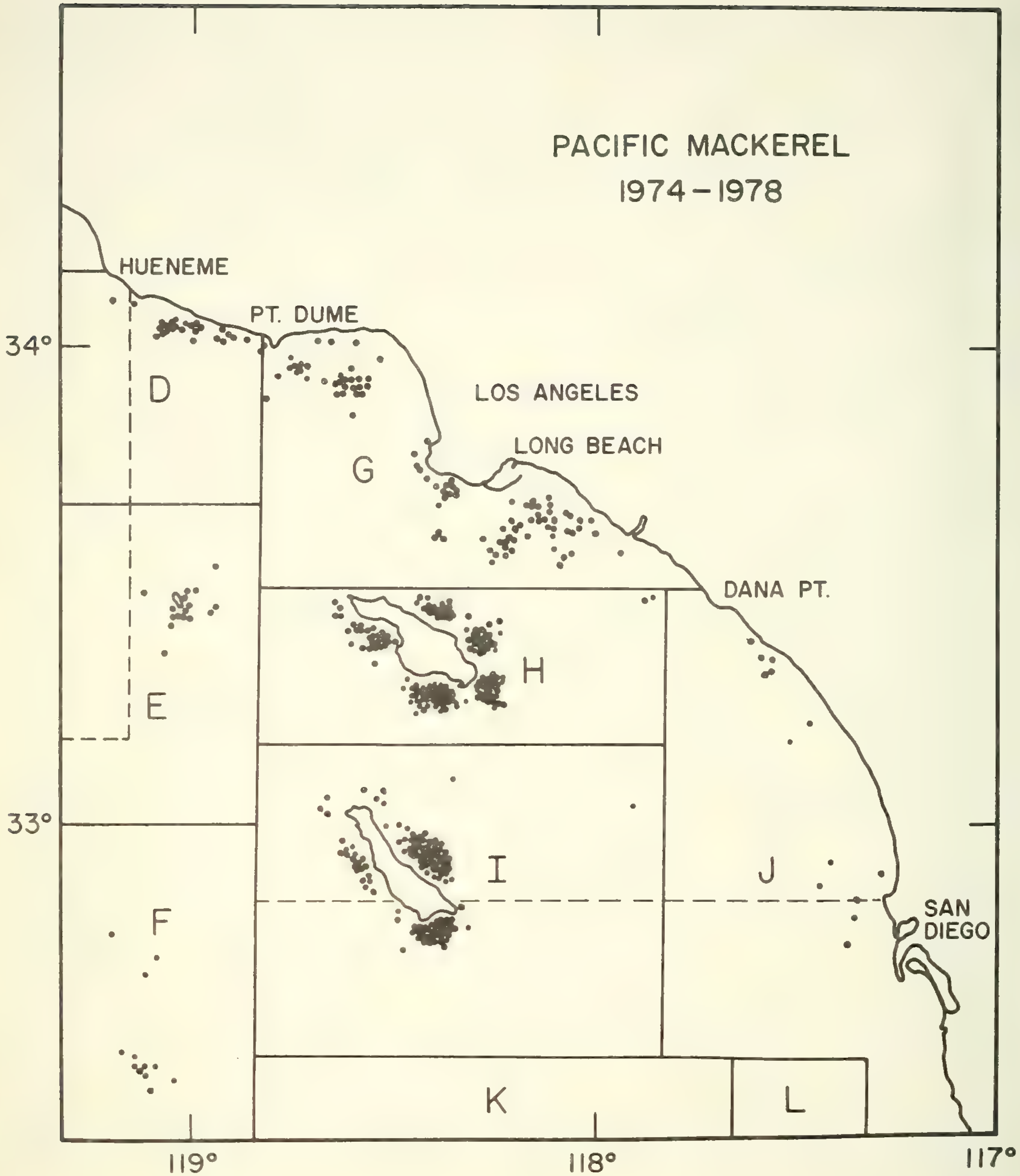


Figure 36.—Pacific mackerel—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1974-78.

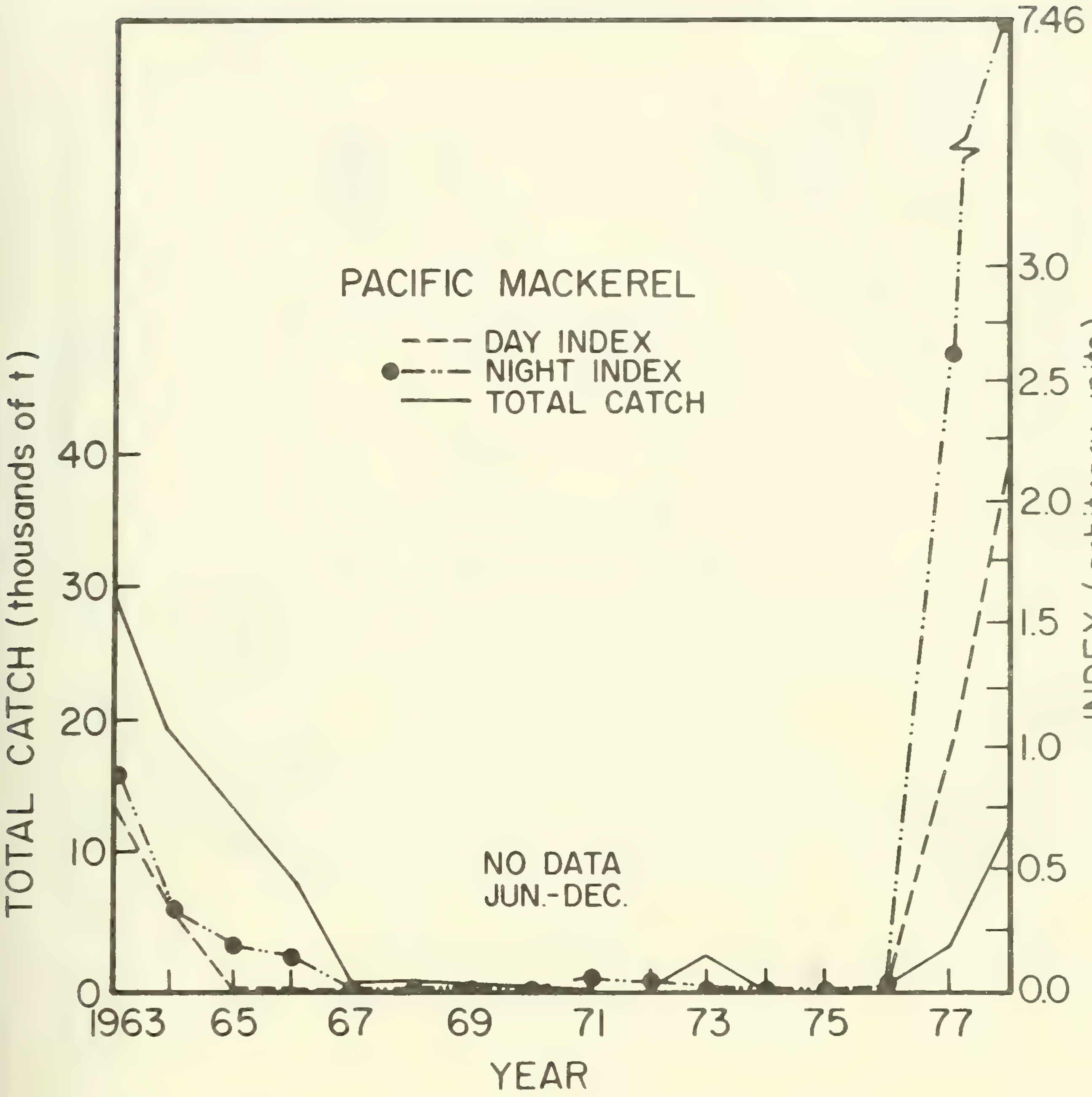


Figure 37.—Pacific mackerel index values in arbitrary units for day and night observations and total California catch.

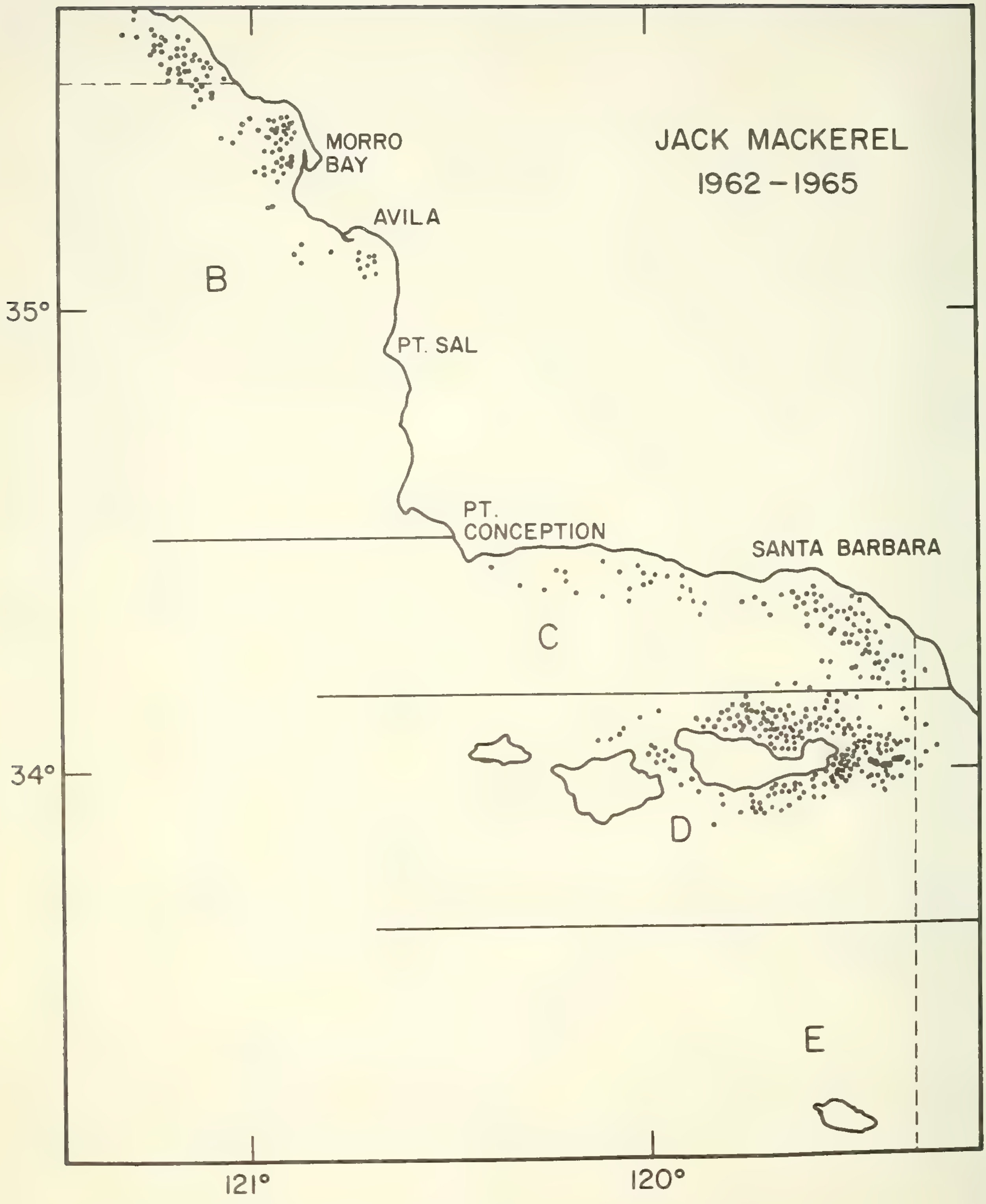


Figure 38.—Jack mackerel—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1962-65.

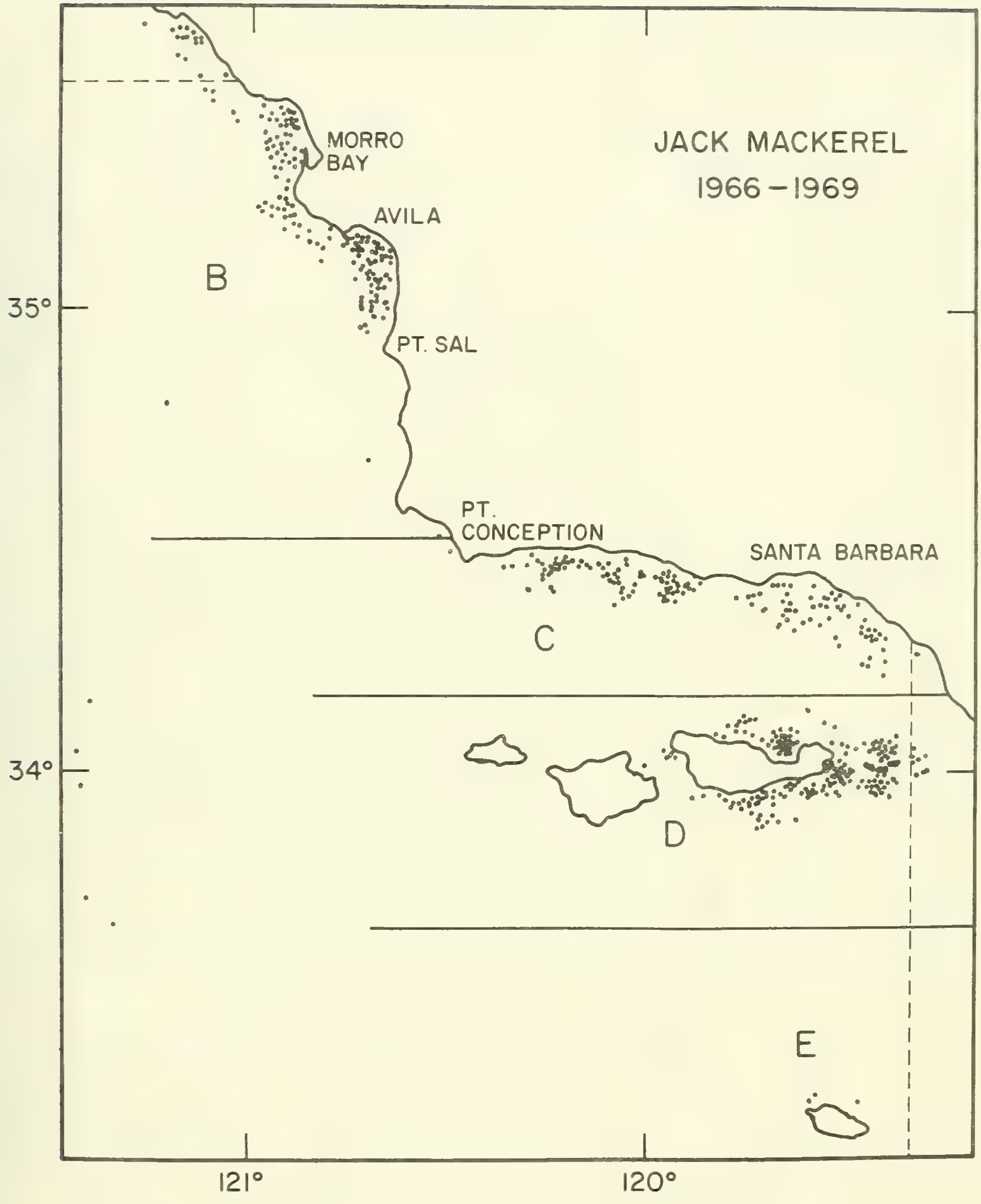


Figure 39.—Jack mackerel—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1966-69.

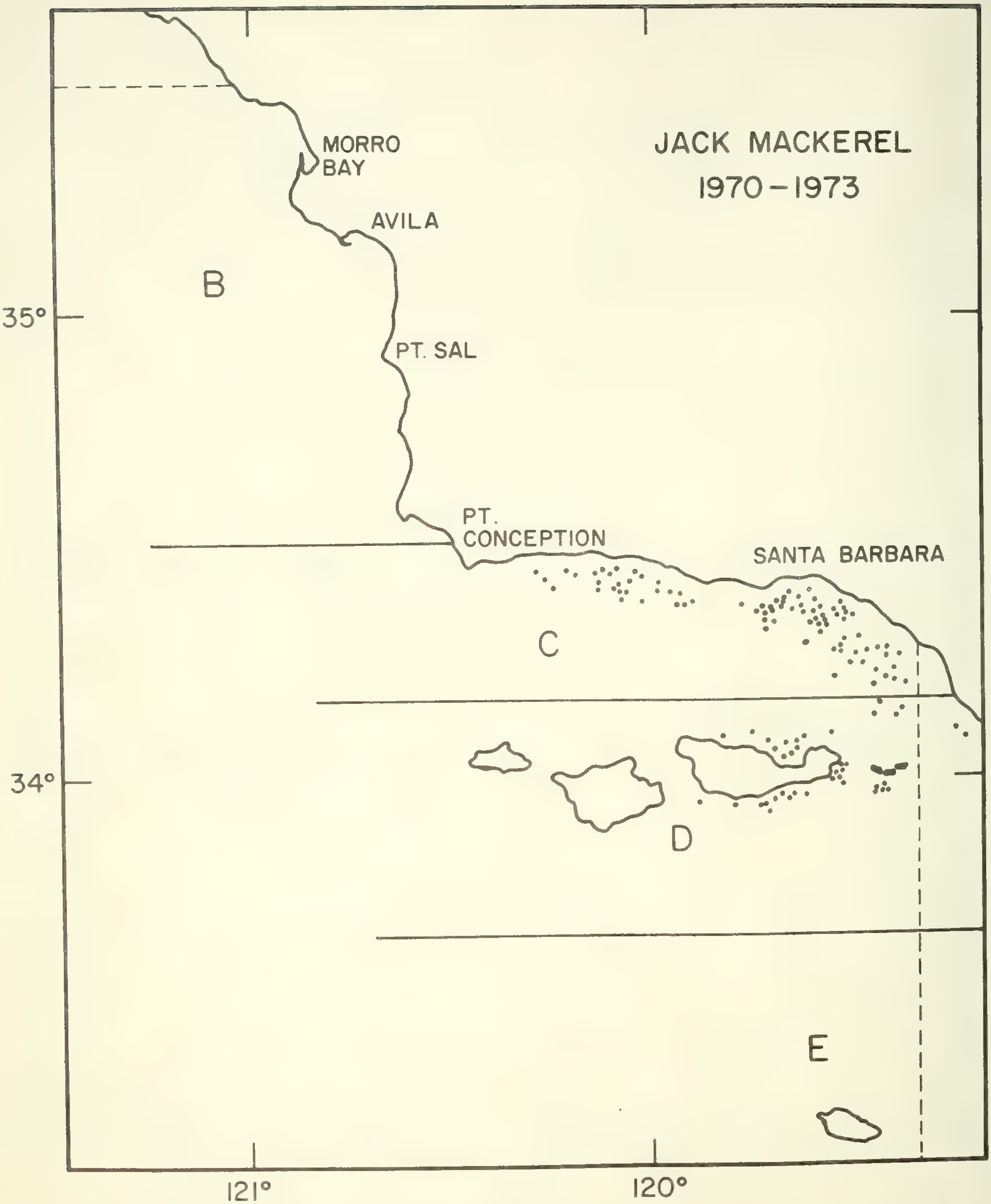


Figure 40.—Jack mackerel—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1970-73.

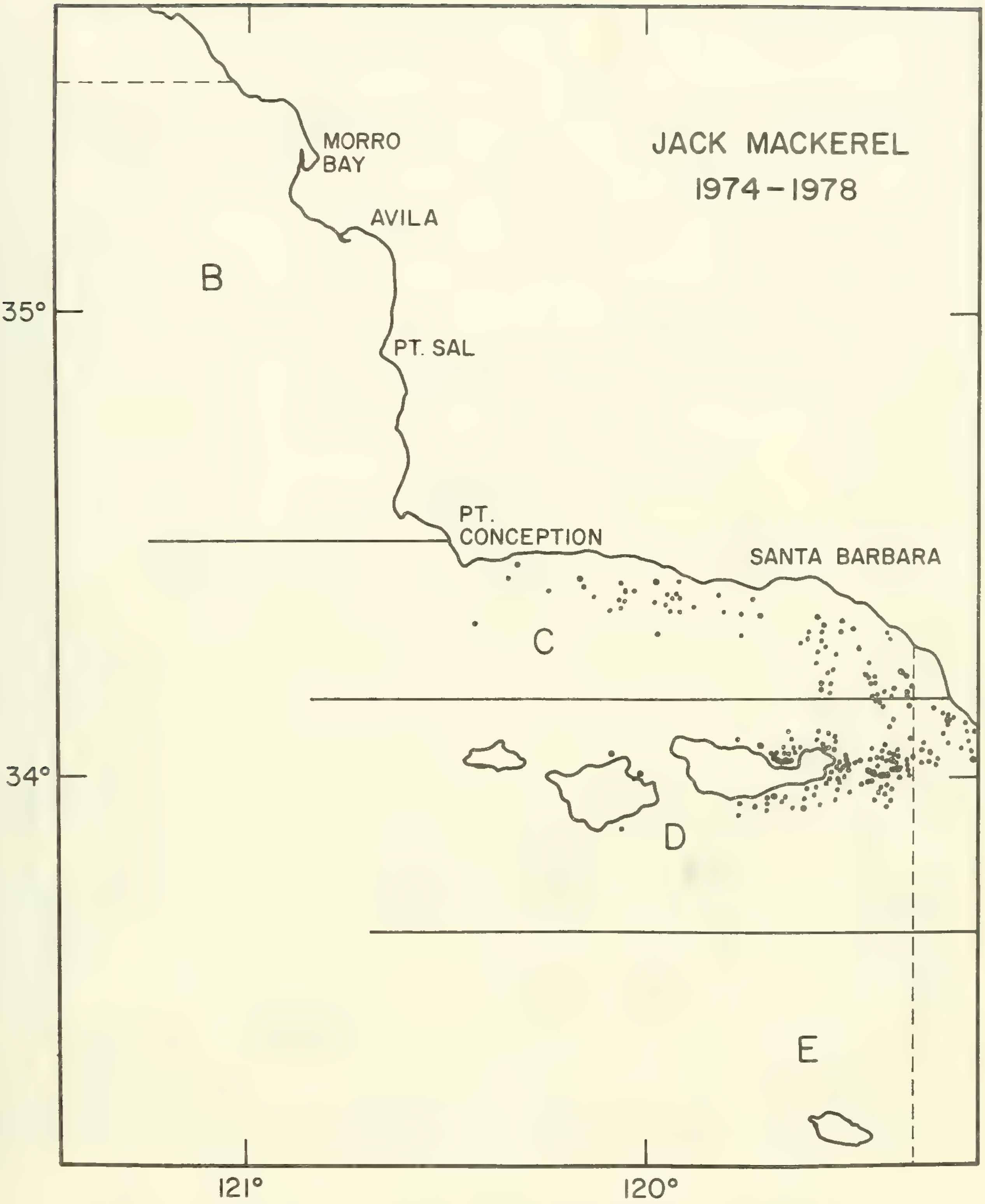


Figure 41.—Jack mackerel—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1974-78.

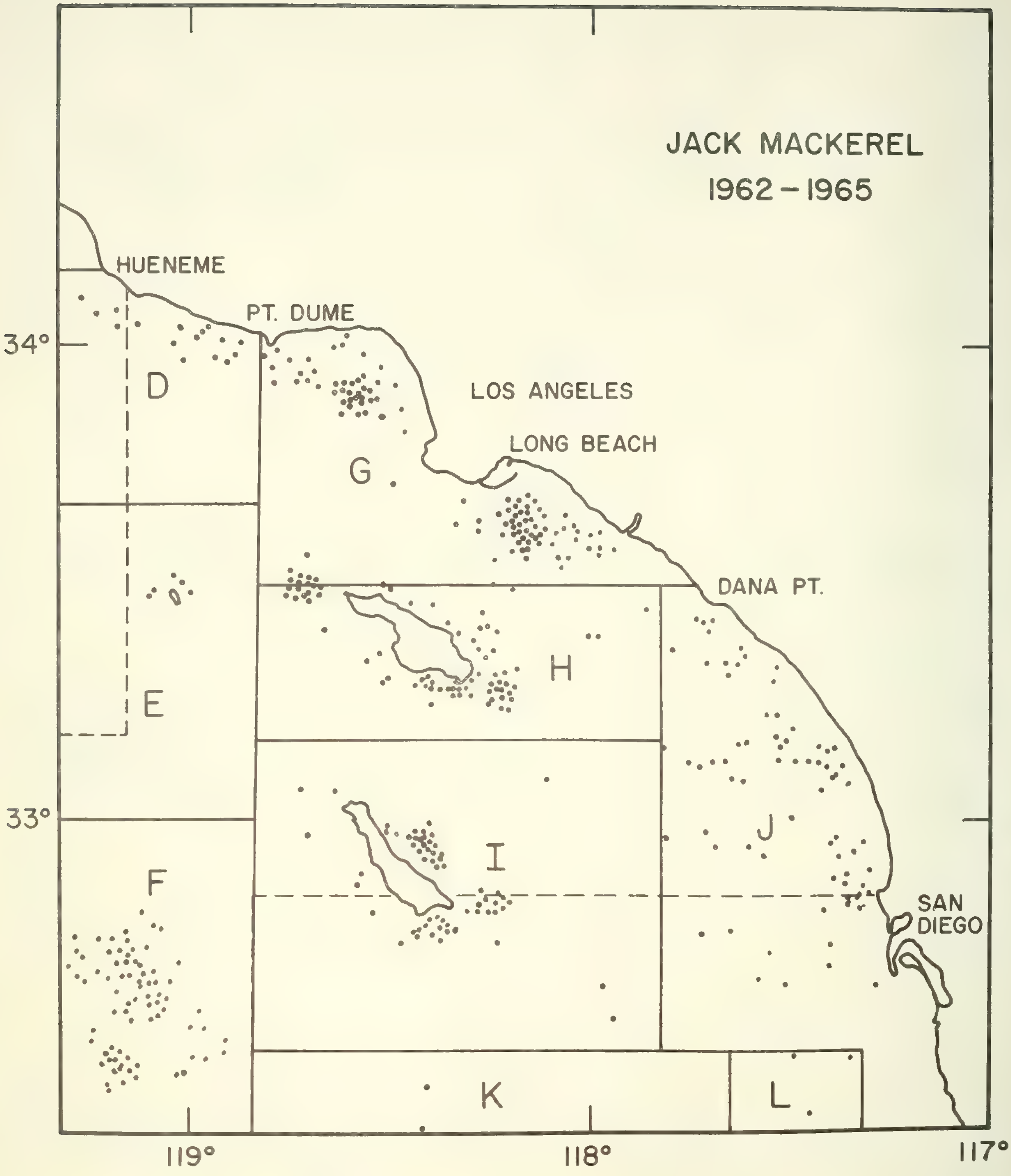


Figure 42.—Jack mackerel—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1962-65.

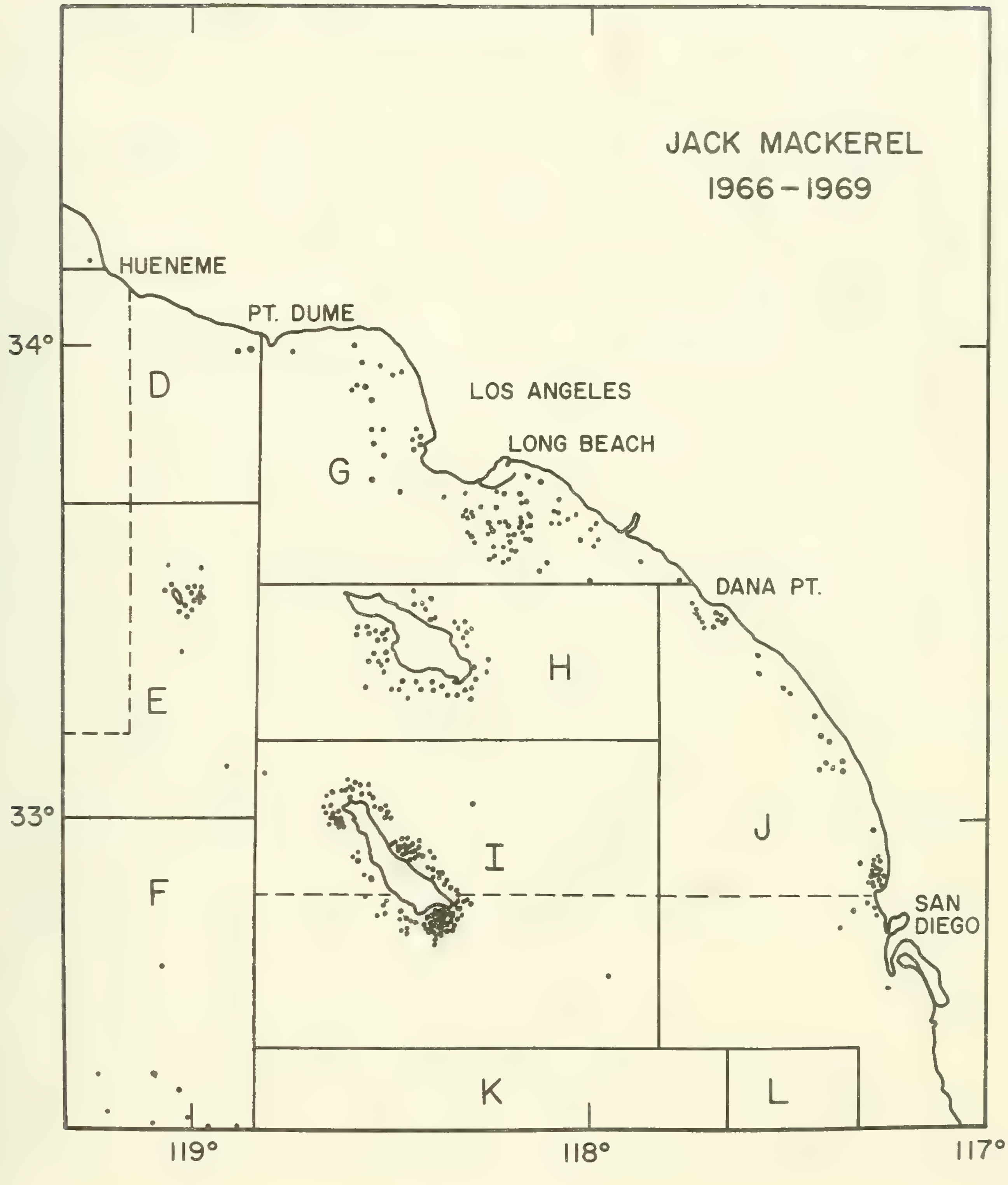


Figure 43.—Jack mackerel—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1966-69.

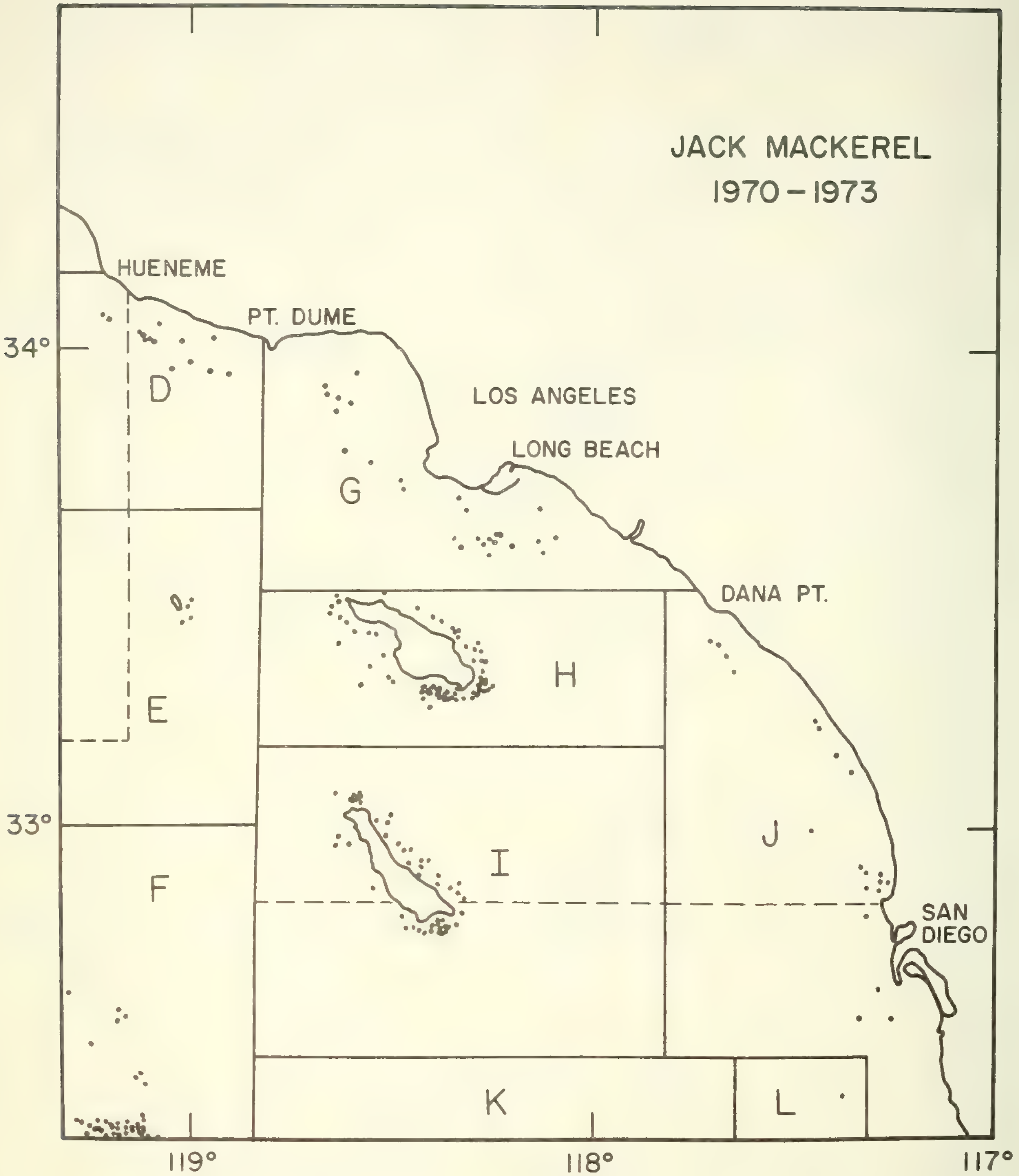


Figure 44.—Jack mackerel—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1970-73.

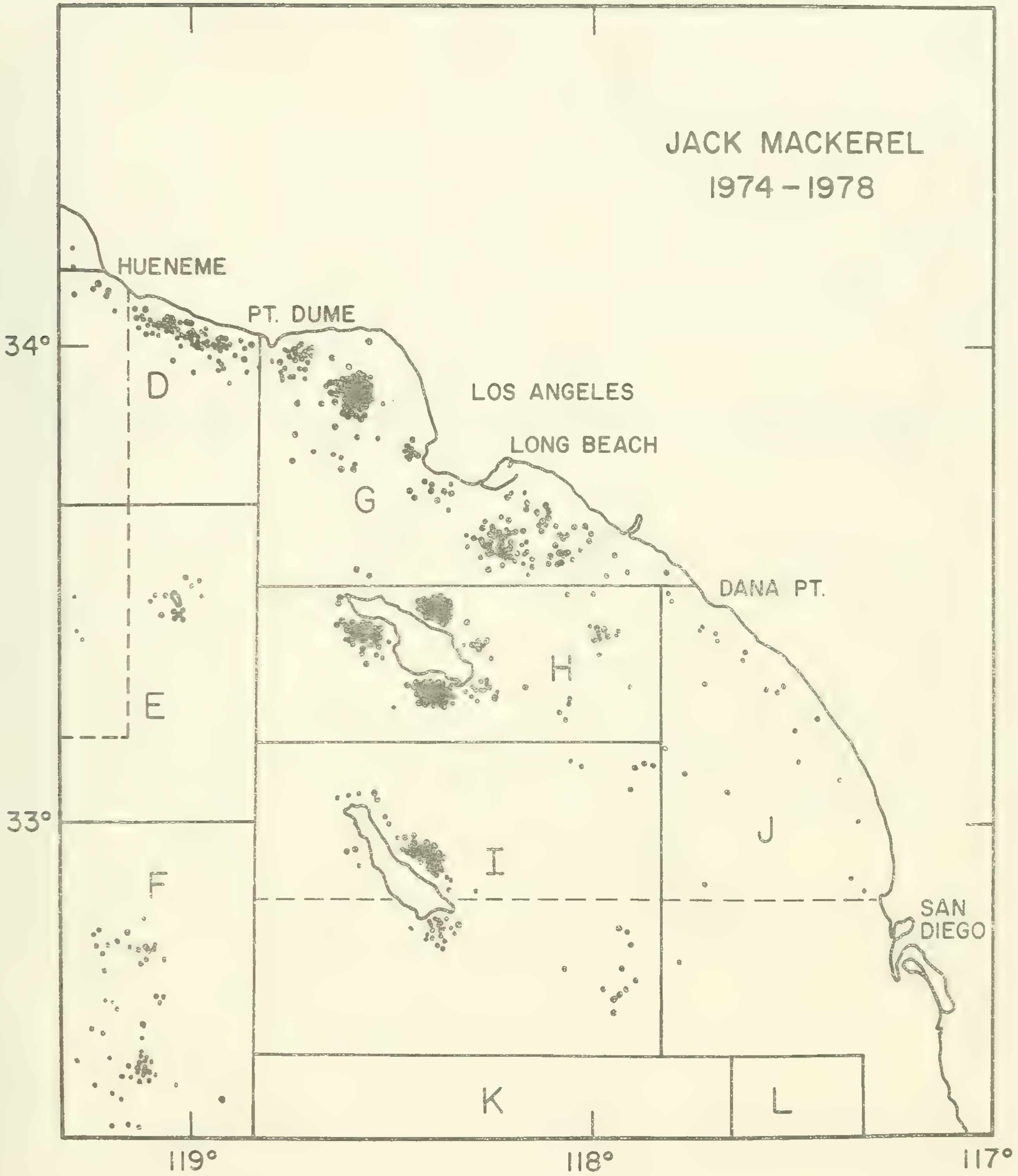


Figure 45.—Jack mackerel—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1974-78.

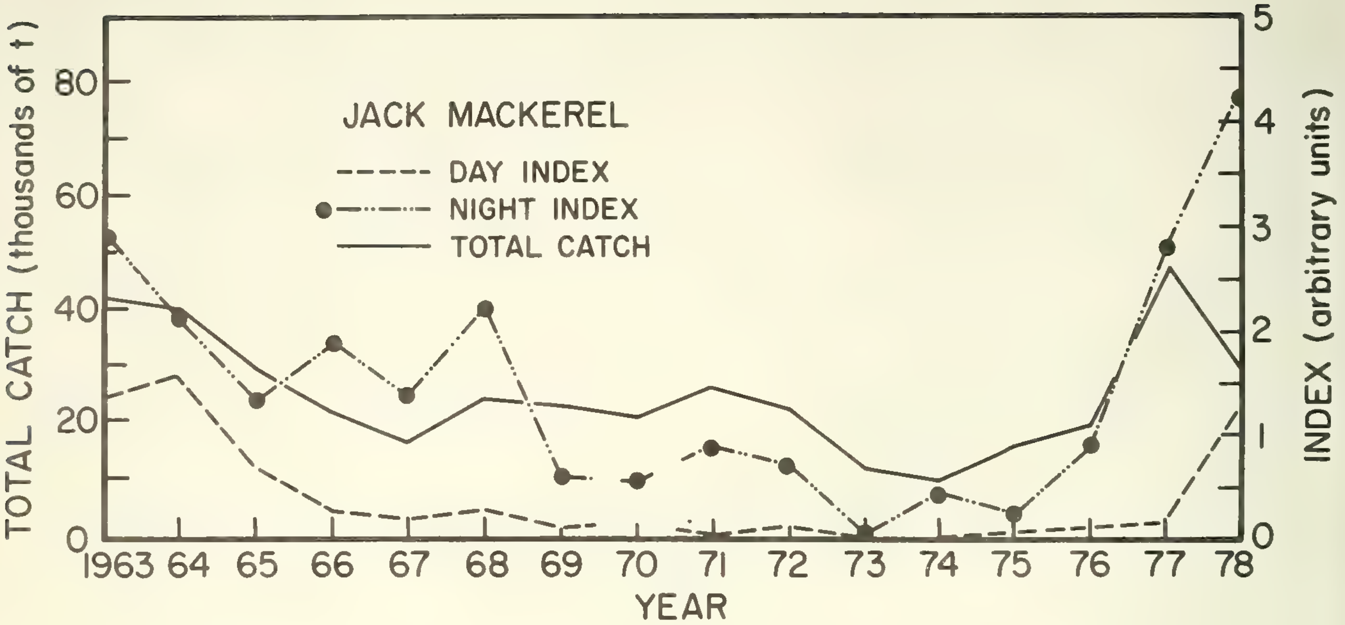


Figure 46.—Jack mackerel index values in arbitrary units for day and night observations and total California catch.

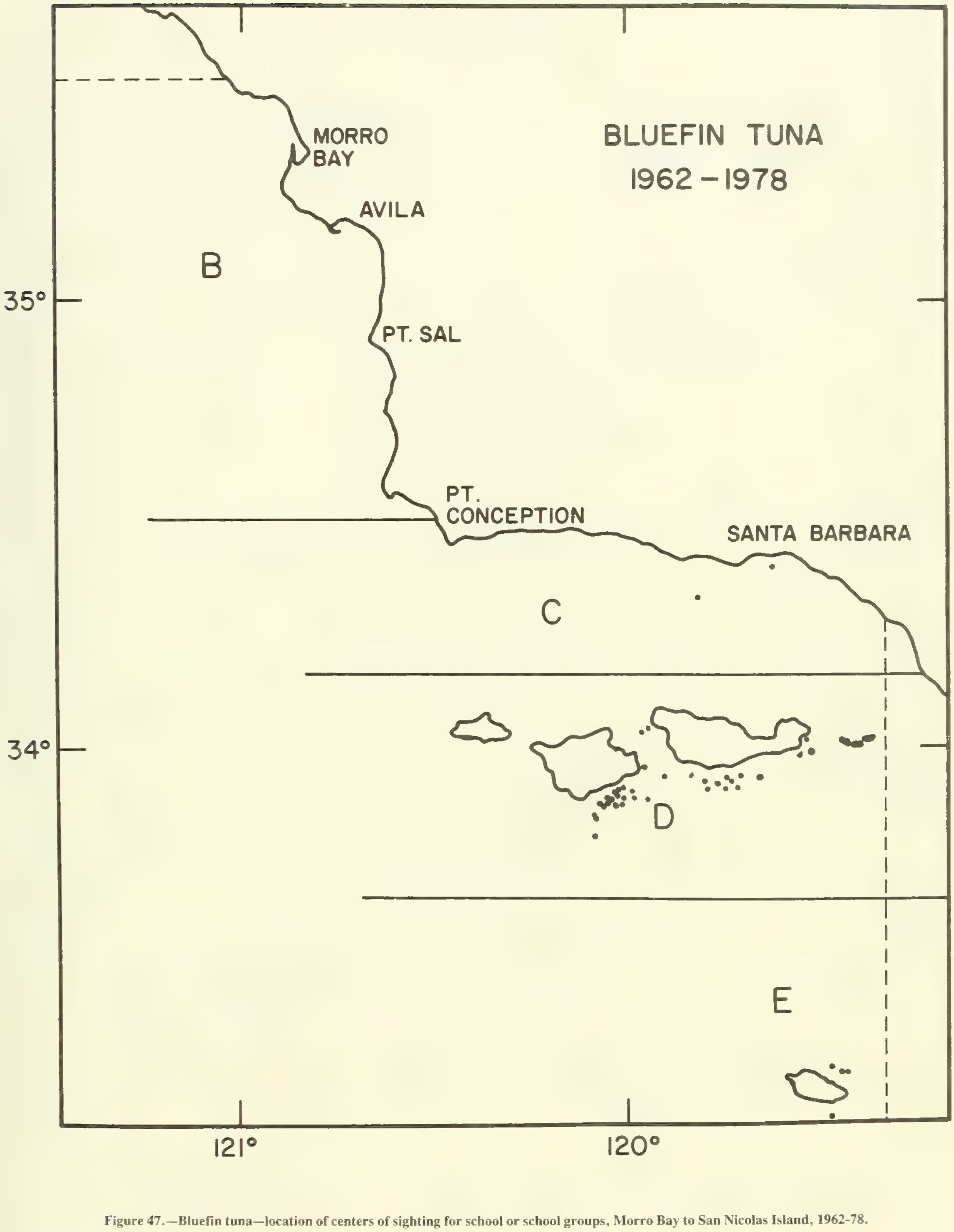


Figure 47.—Bluefin tuna—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1962-78.

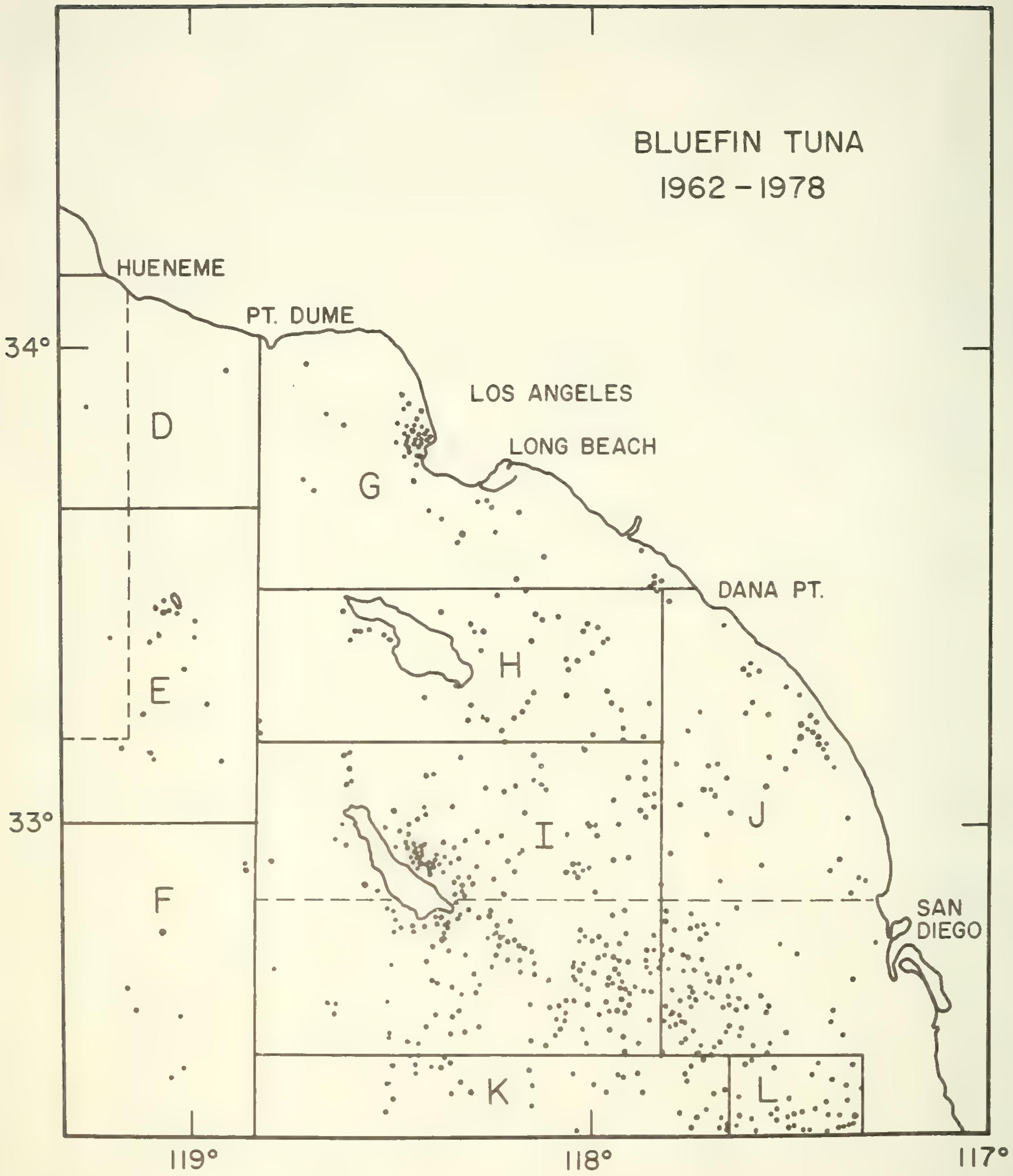


Figure 48.—Bluefin tuna—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1962-78.

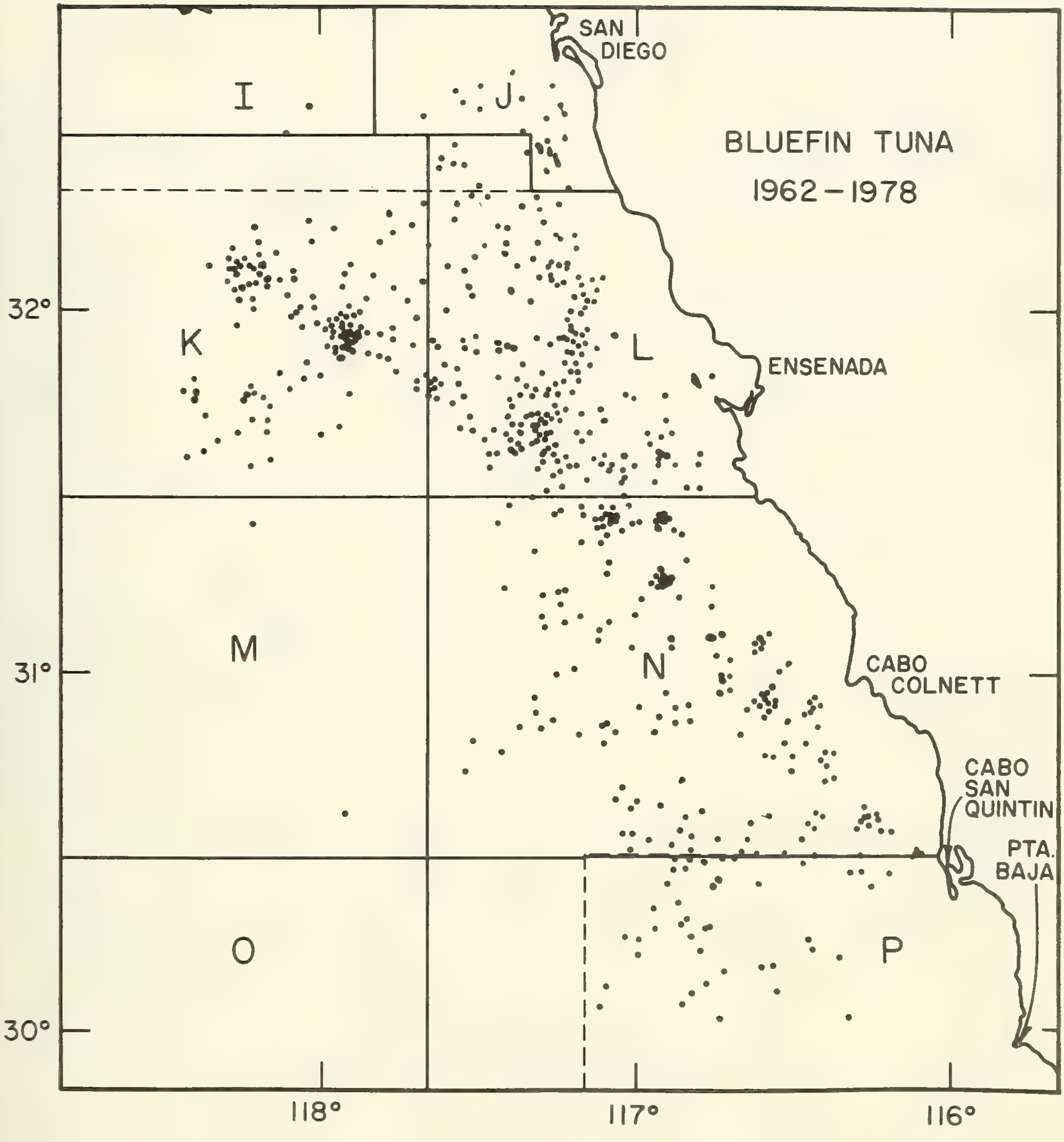


Figure 49.—Bluefin tuna—location of centers of sighting for school or school groups, San Diego to Punta Baja, 1962-78.

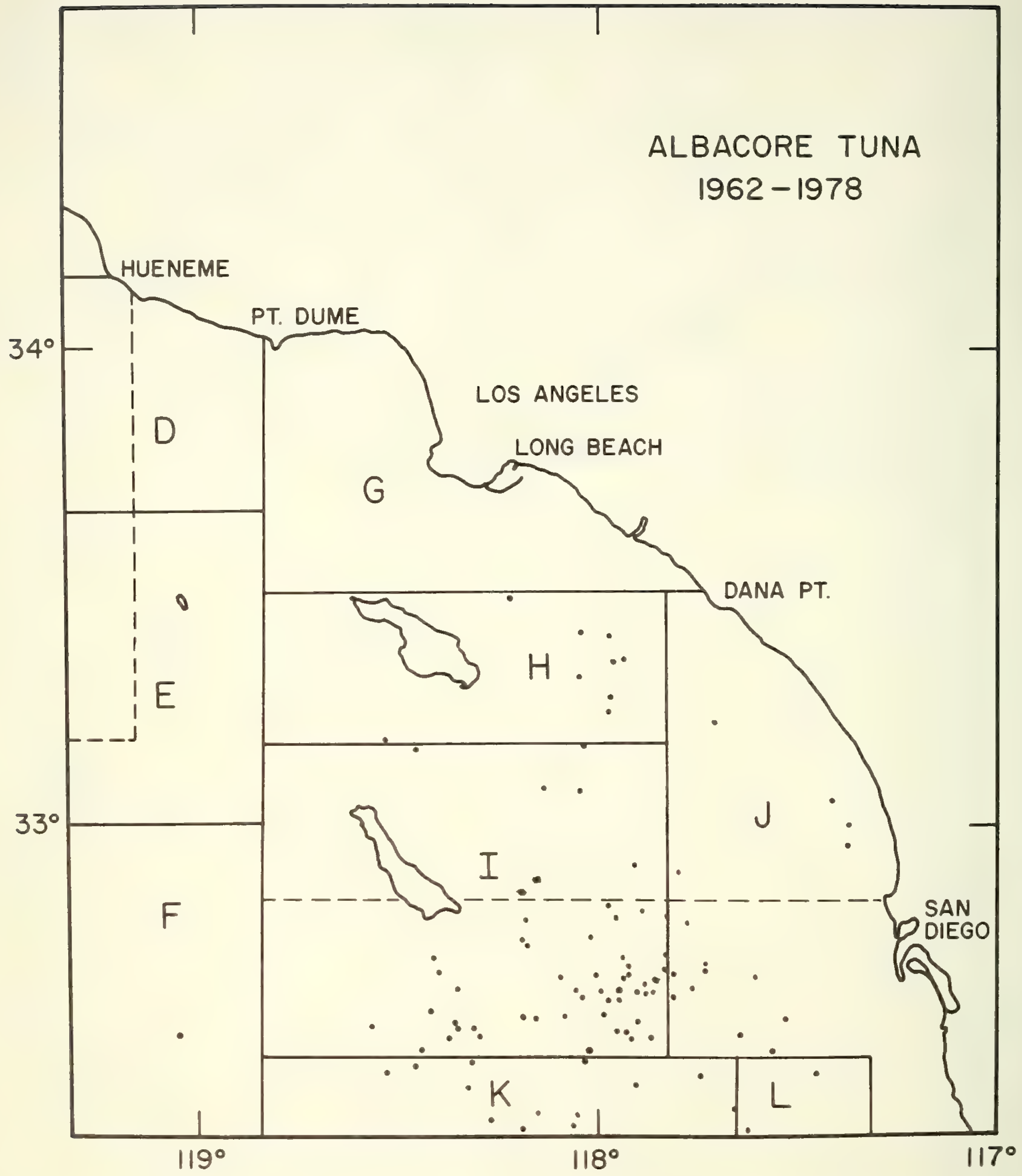


Figure 50.—Albacore tuna—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1962-78.

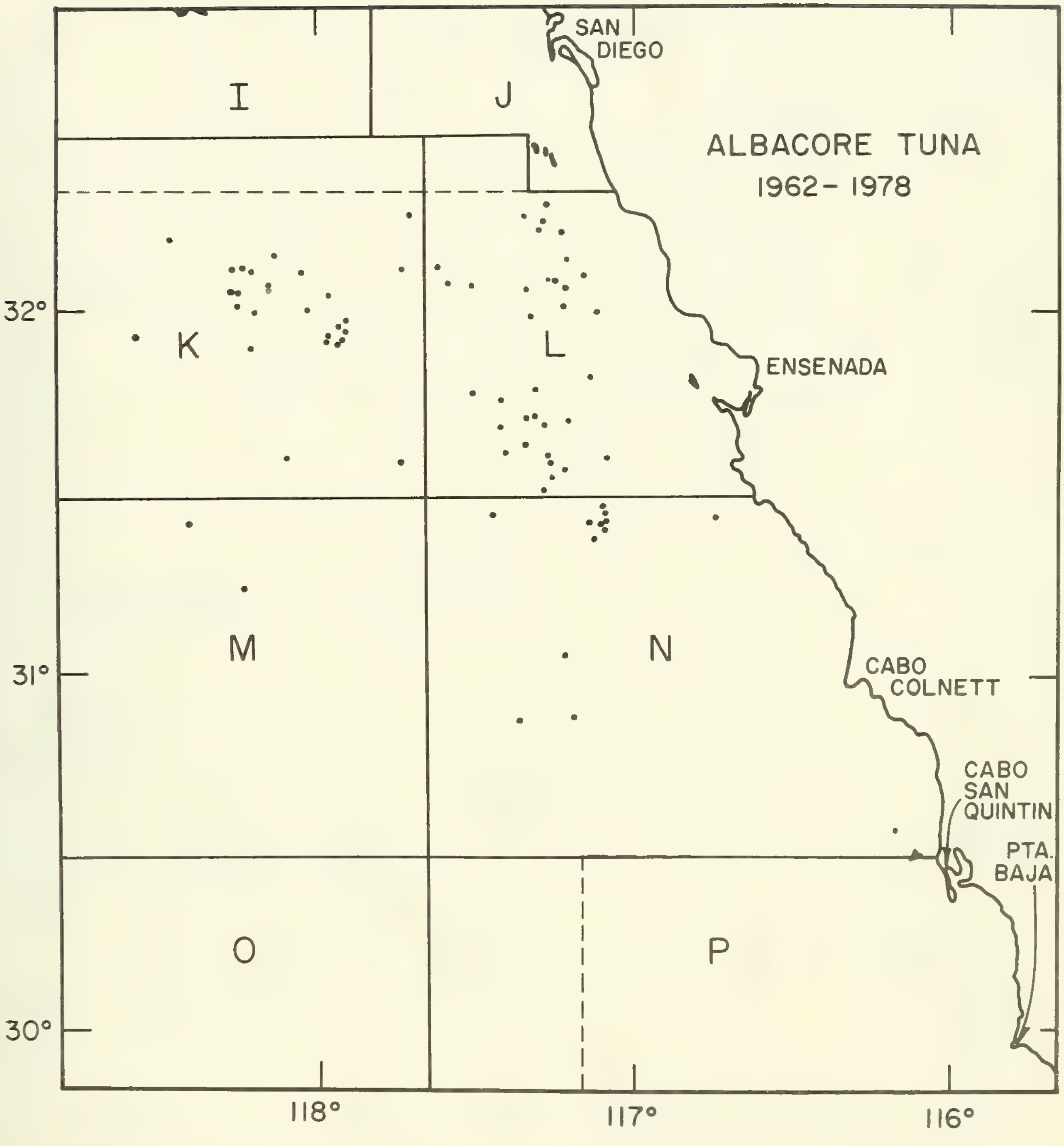


Figure 51.—Albacore tuna—location of centers of sighting for school or school groups, San Diego to Punta Baja, 1962-78.

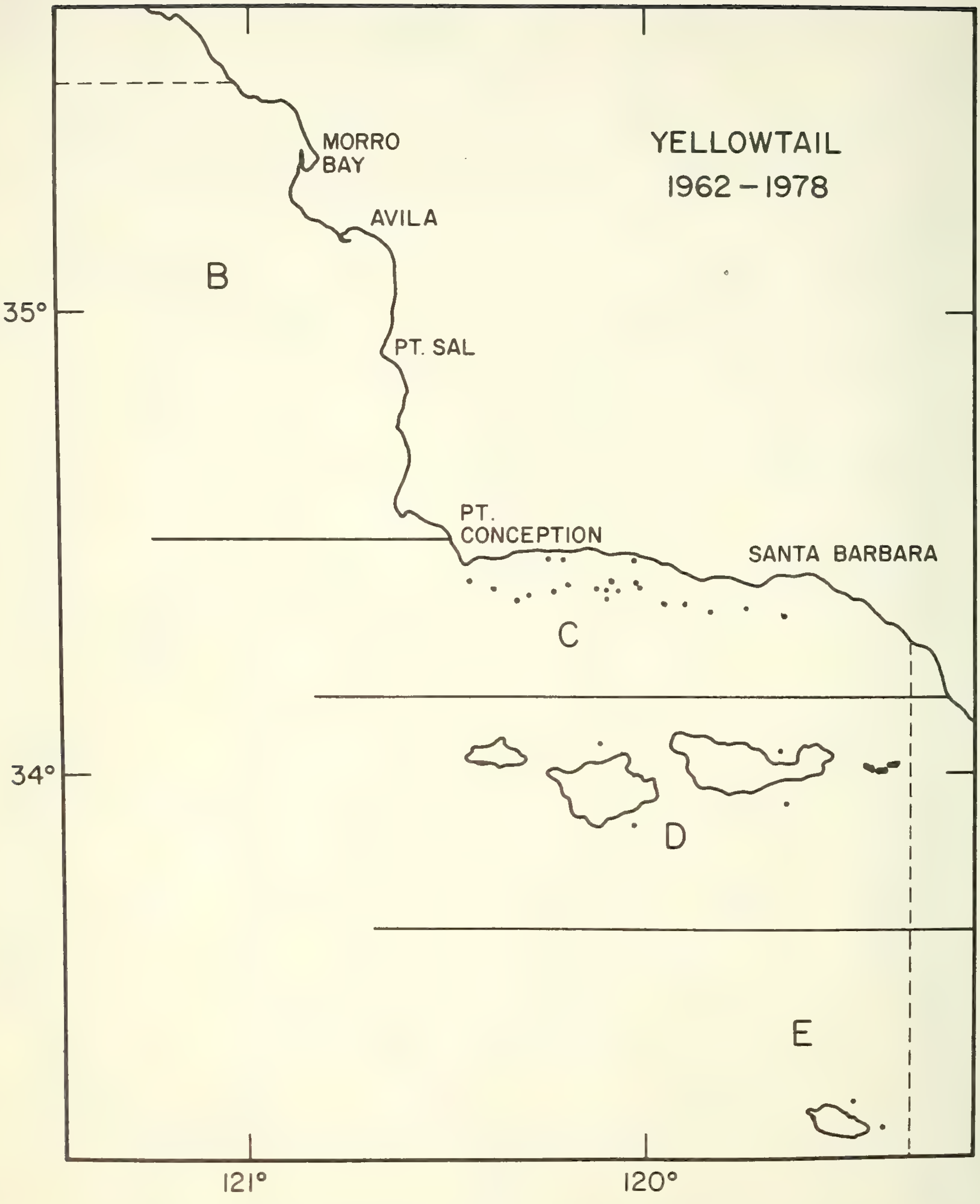


Figure 52.—Yellowtail—locations of school or school group sightings, Morro Bay to San Nicolas Island, 1962-78.

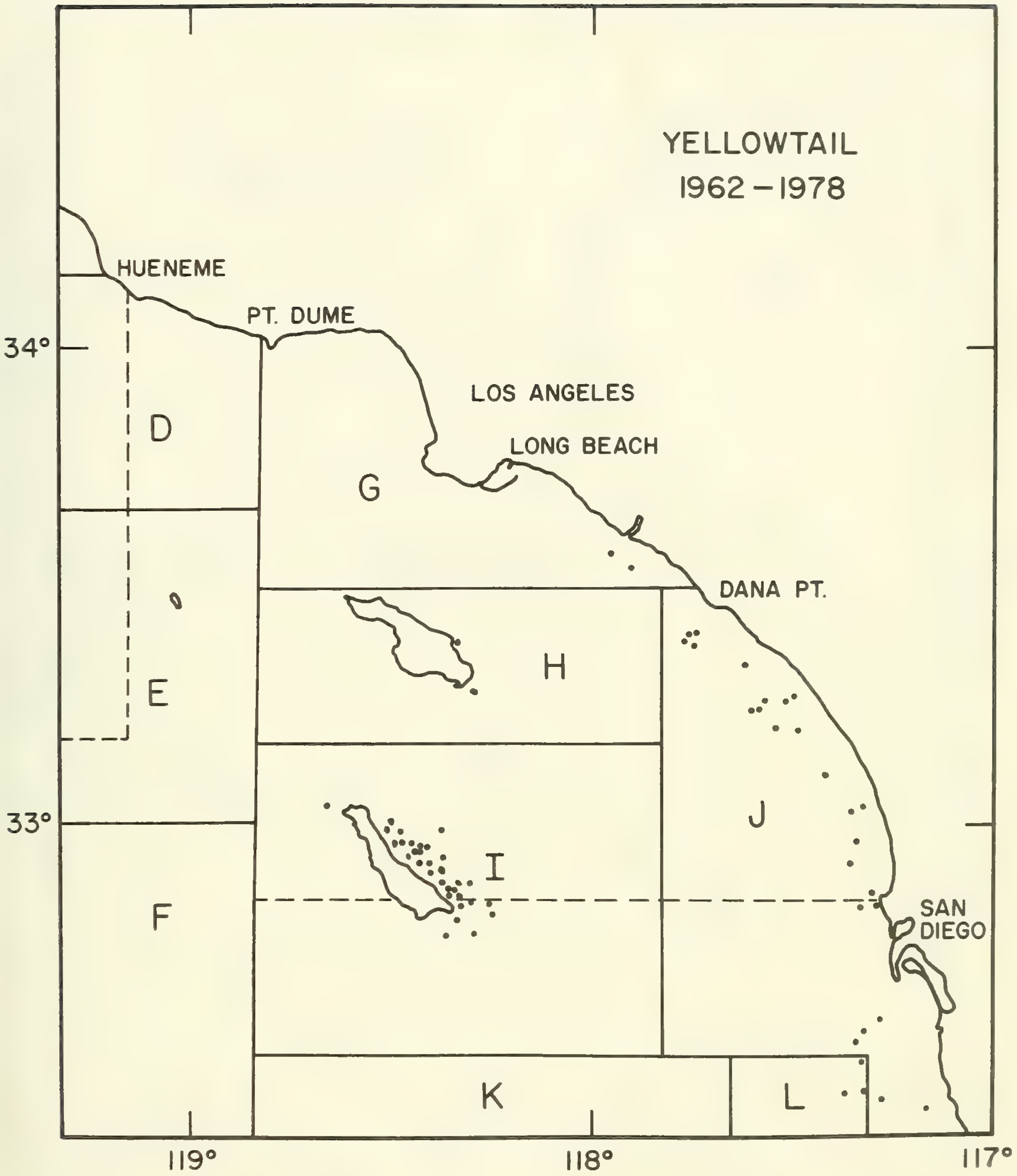


Figure 53.—Yellowtail—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1962-78.

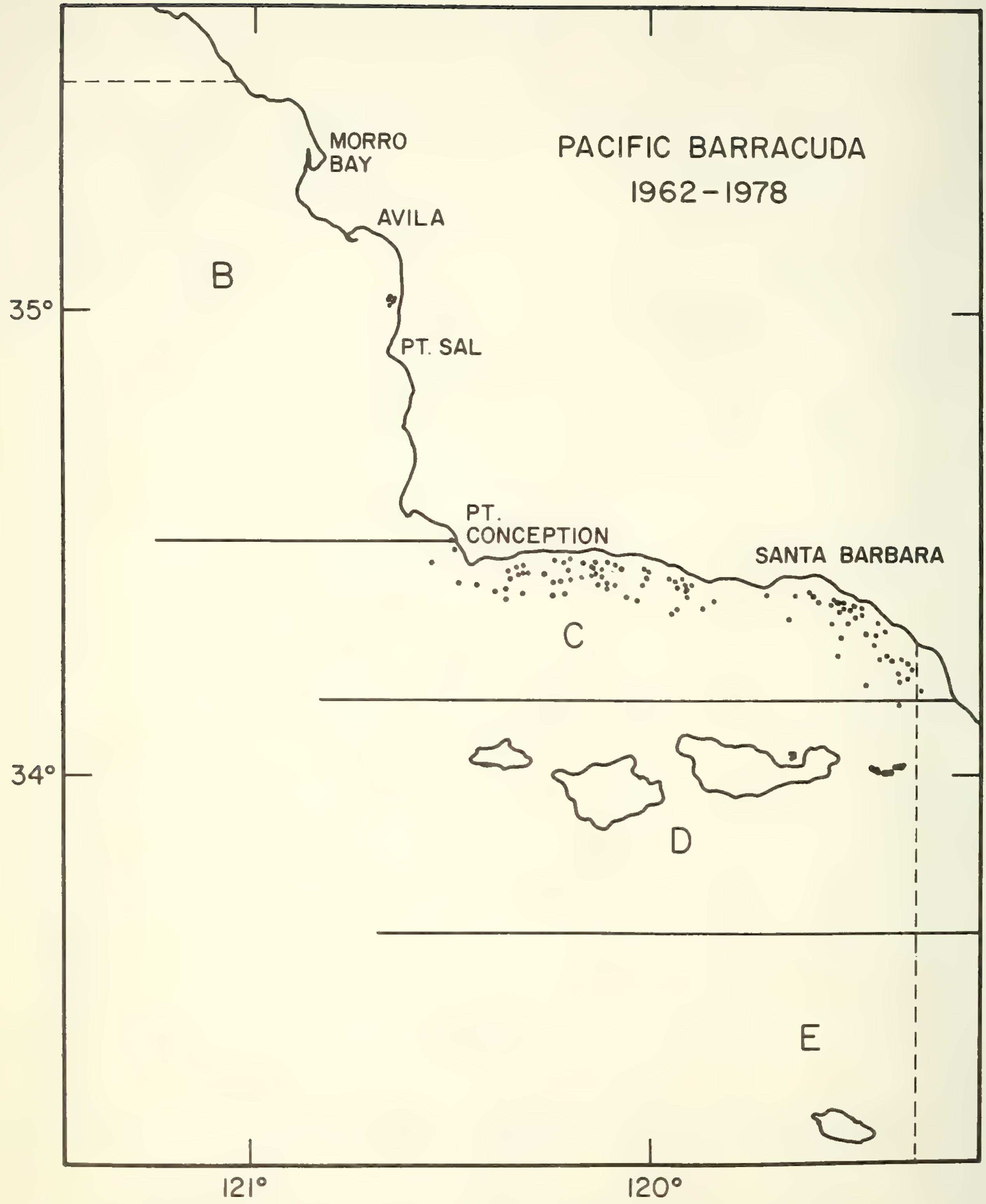


Figure 54.—Pacific barracuda—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1962-78.

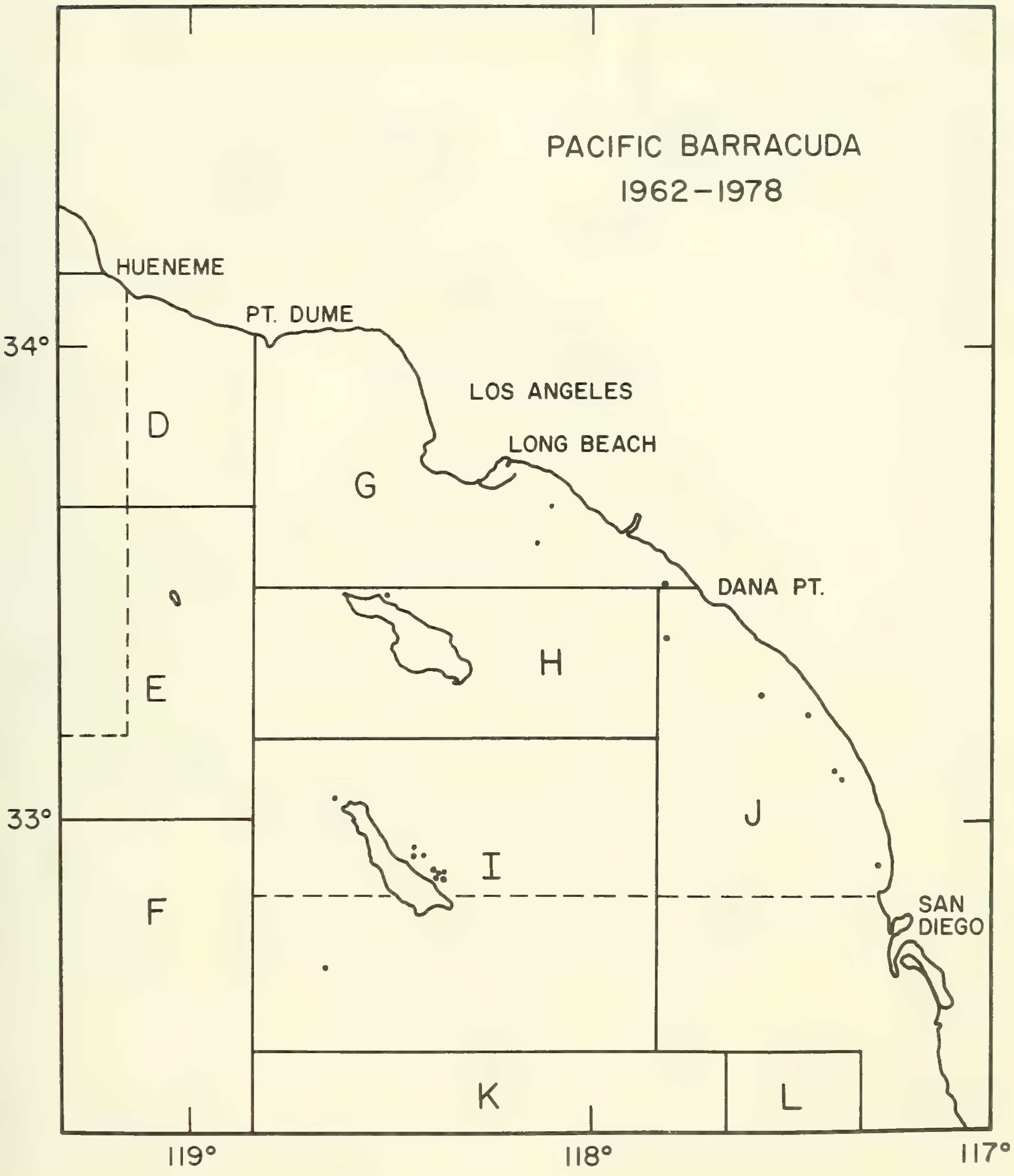


Figure 55.—Pacific barracuda—location of centers of sighting for school or school groups, Pt. Hueneme to San Diego, 1962-78.

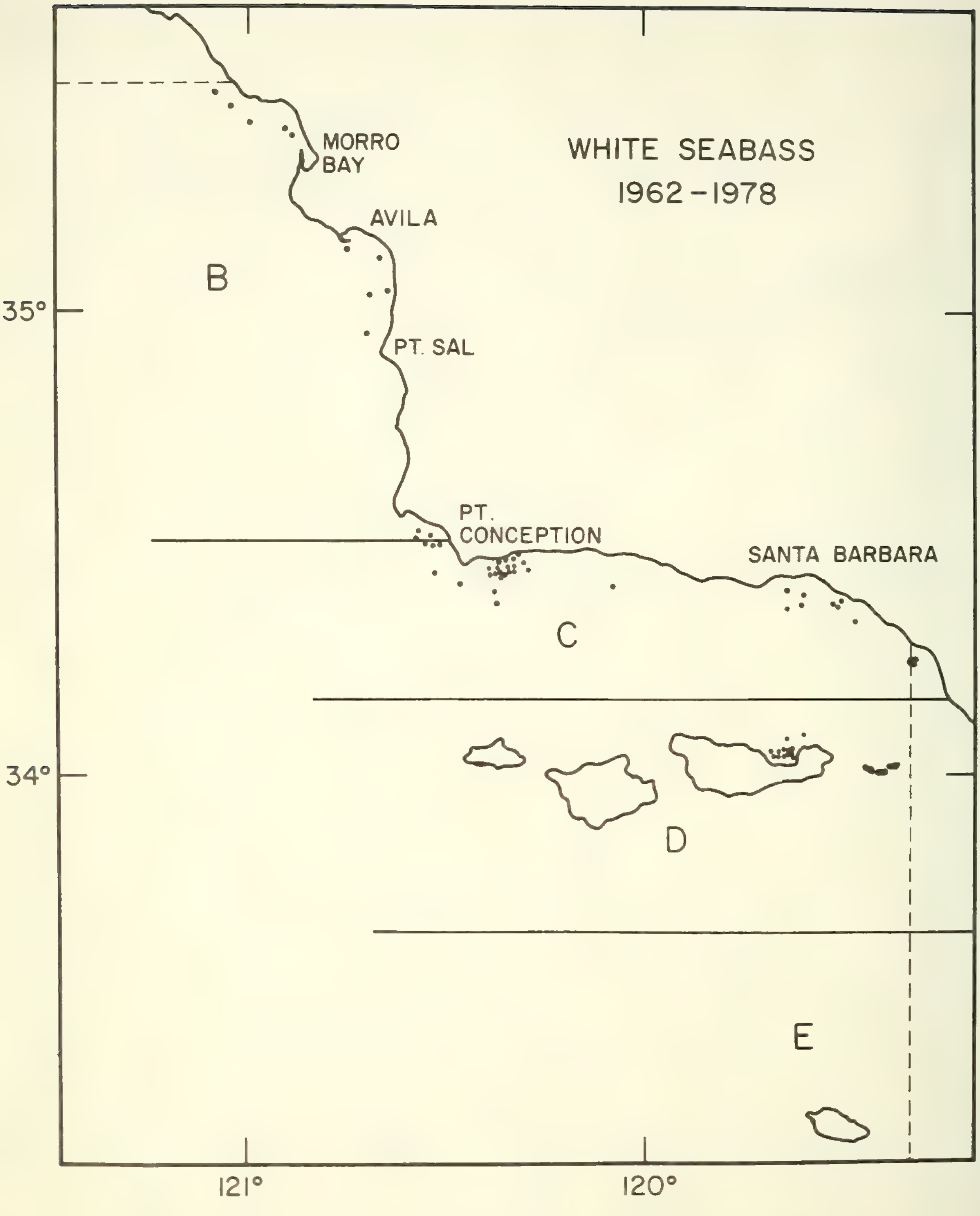
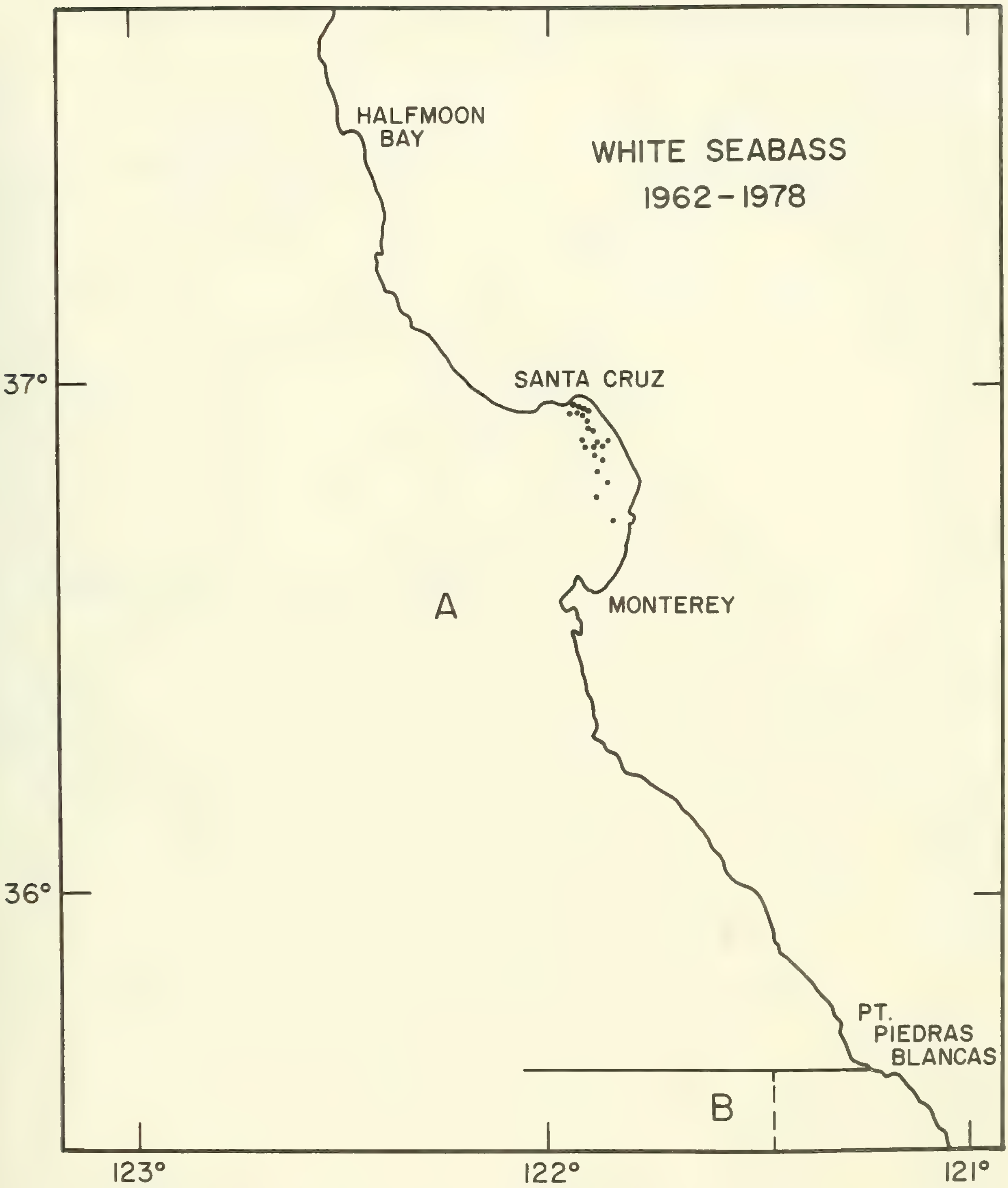


Figure 56.—White seabass—location of centers of sighting for school or school groups, Morro Bay to San Nicolas Island, 1962-78.



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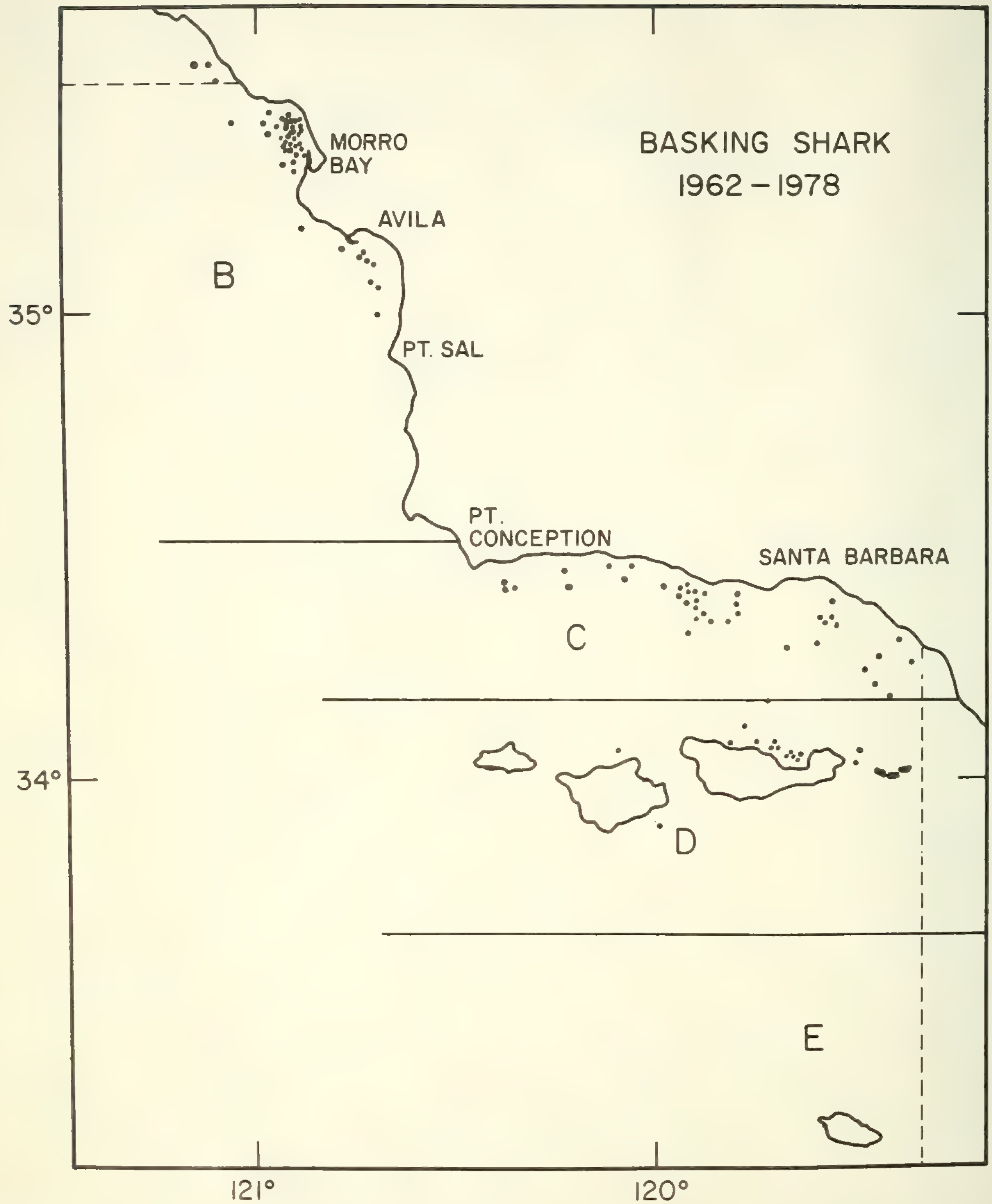

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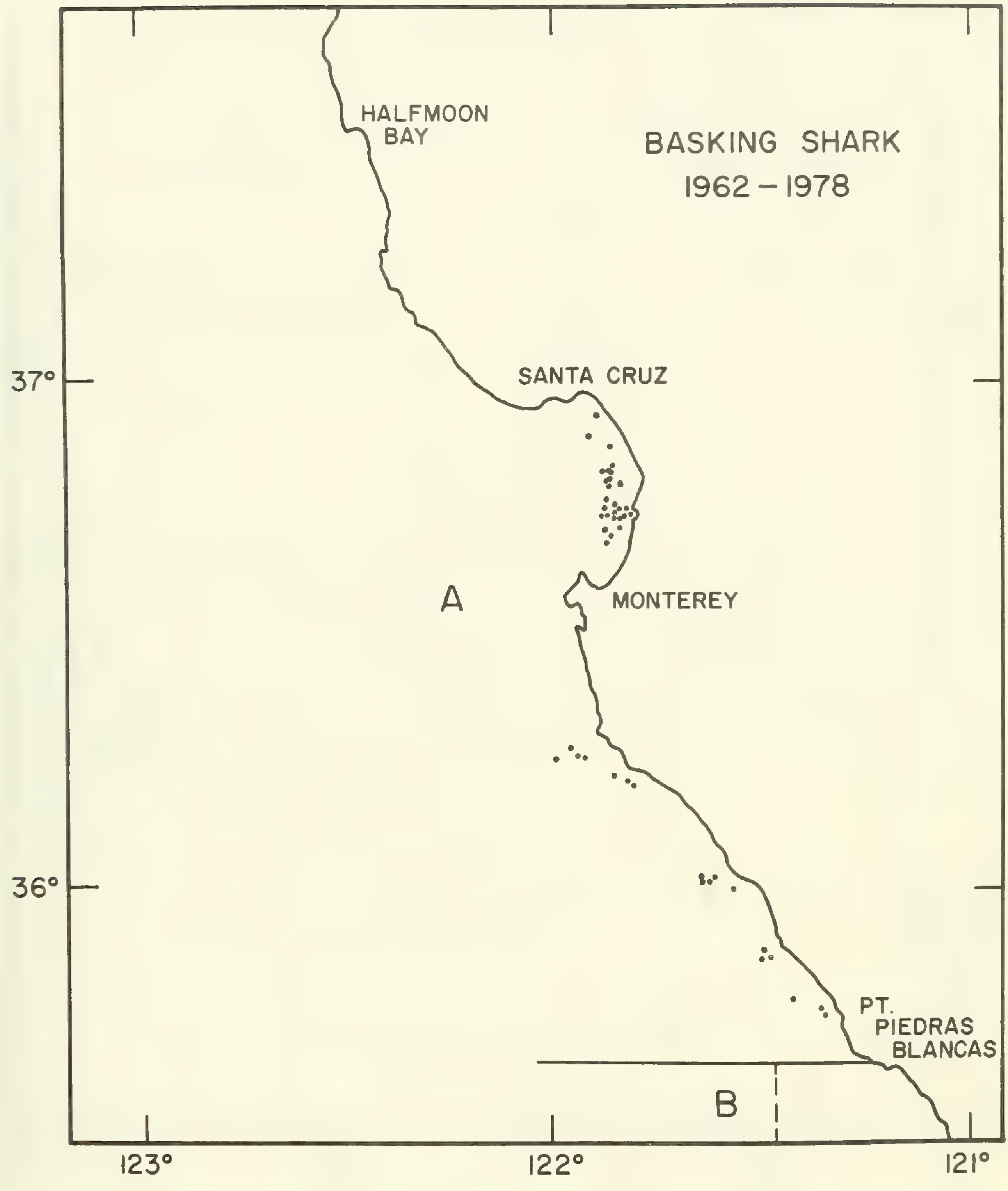

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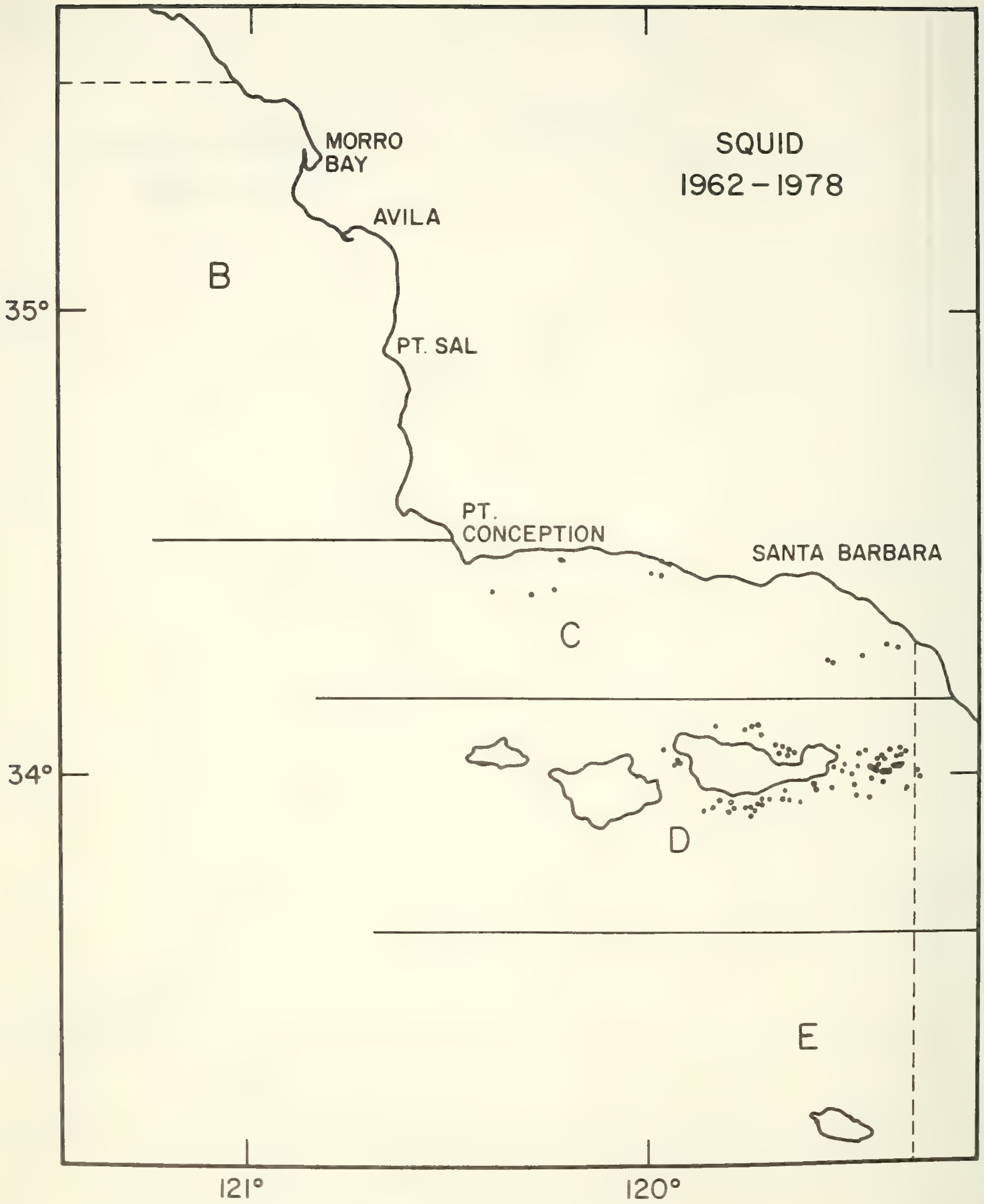

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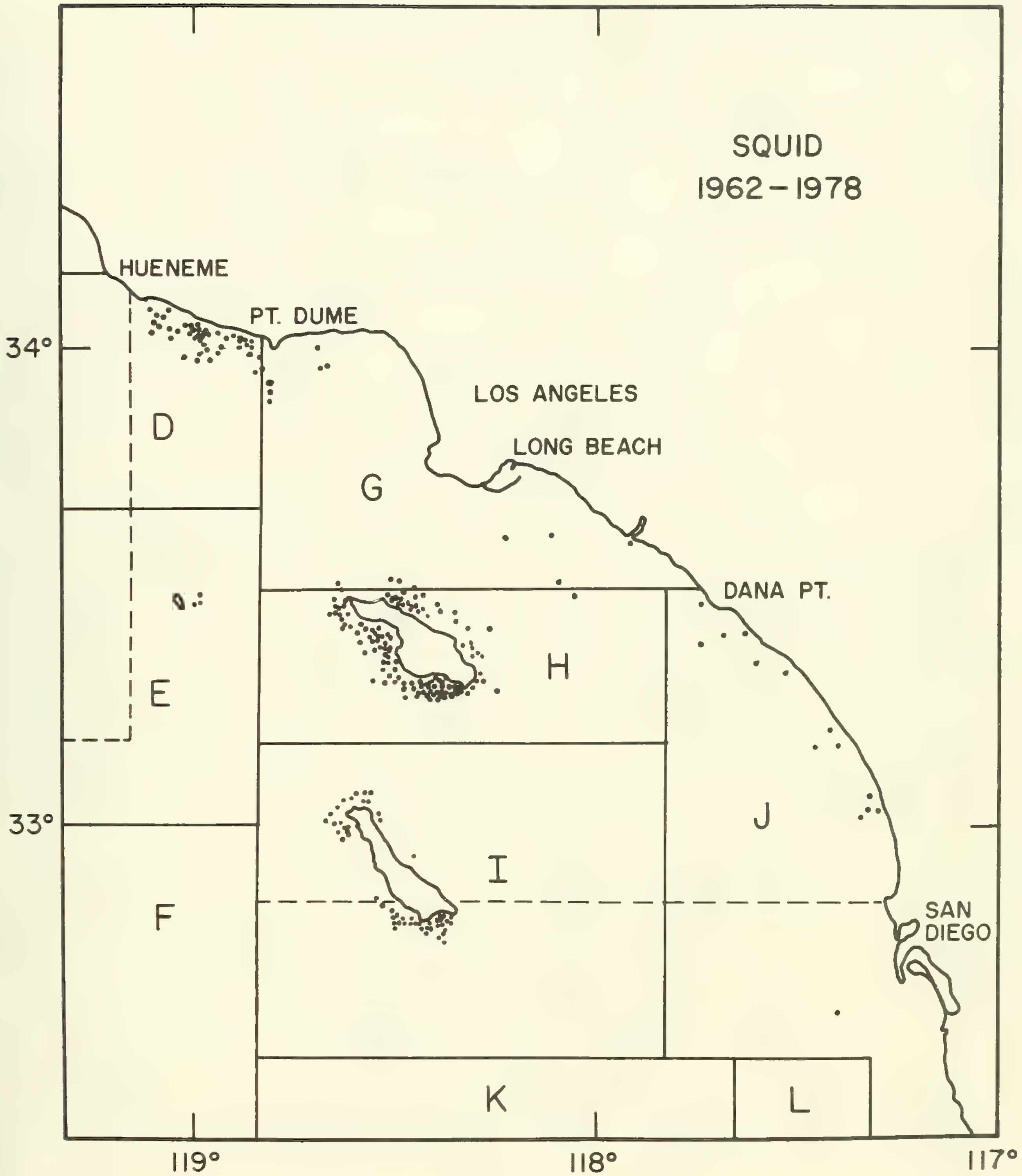

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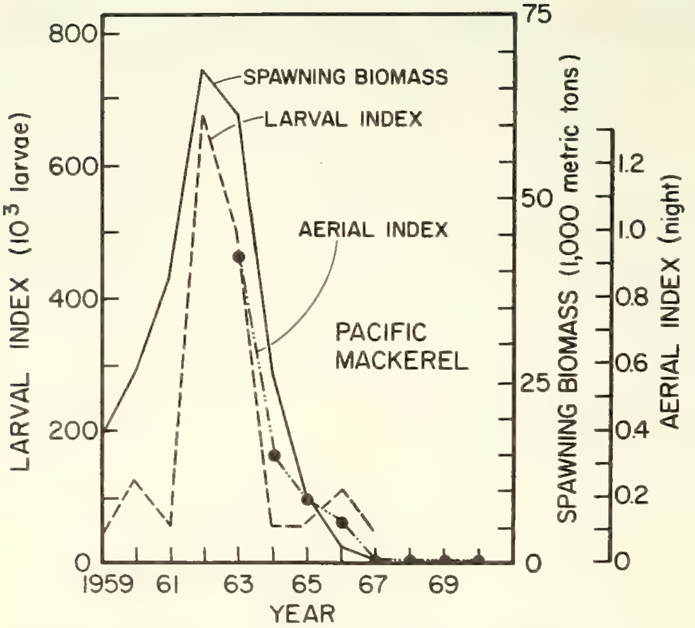

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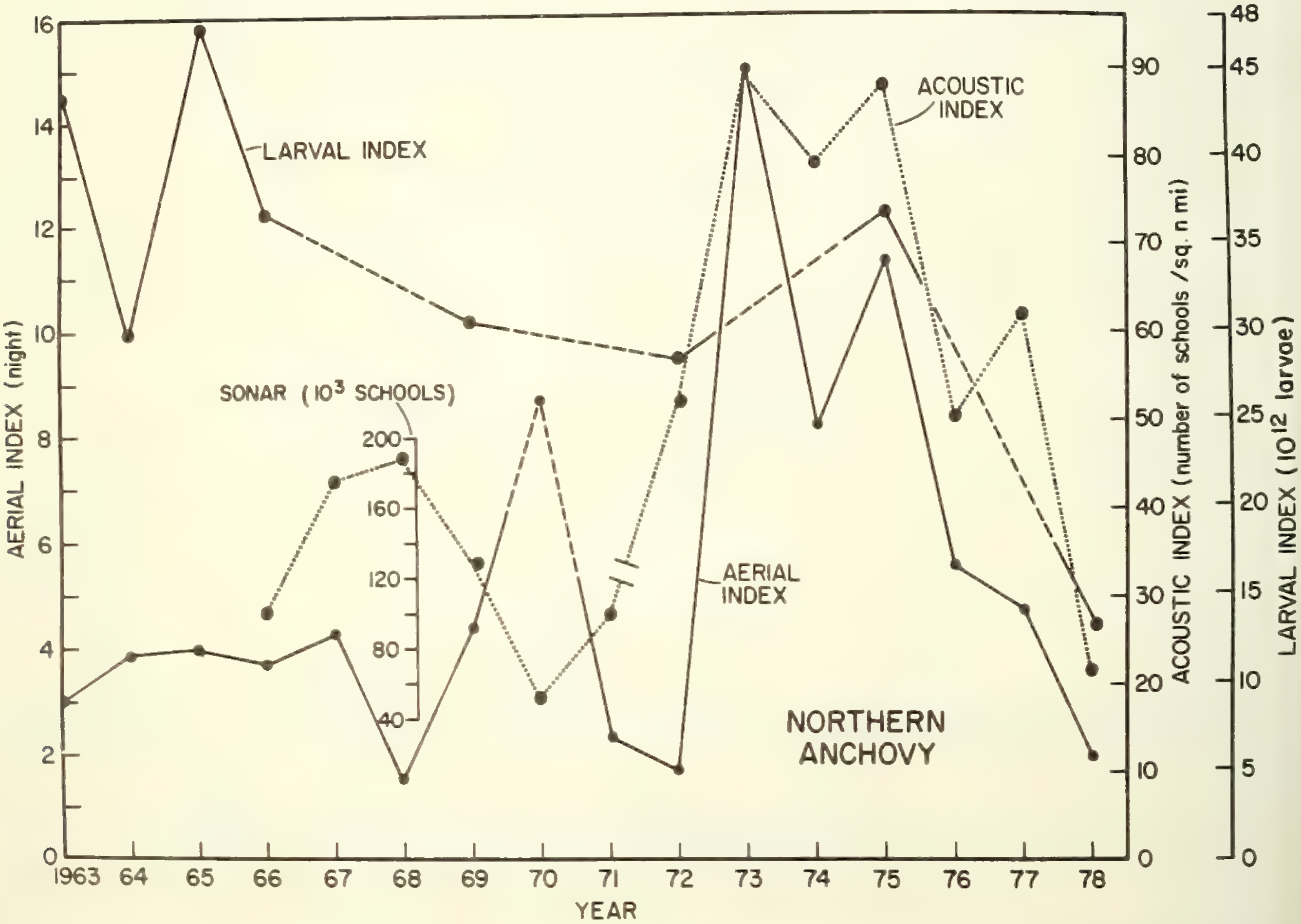

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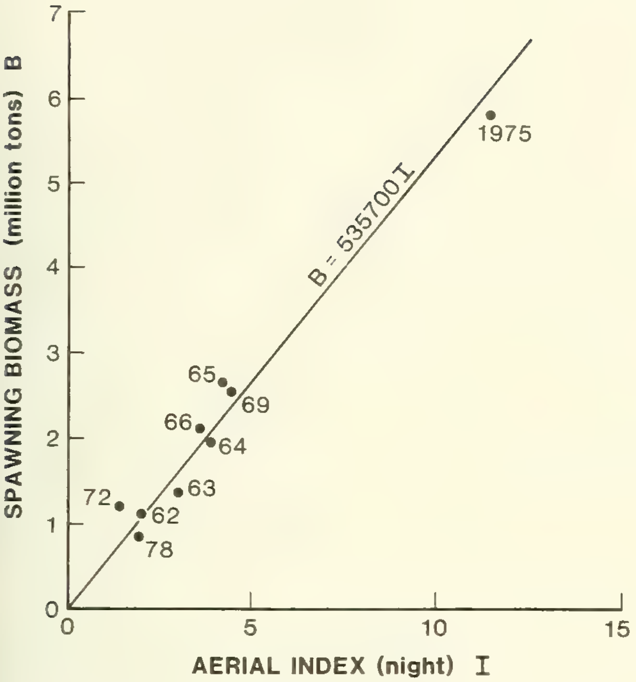

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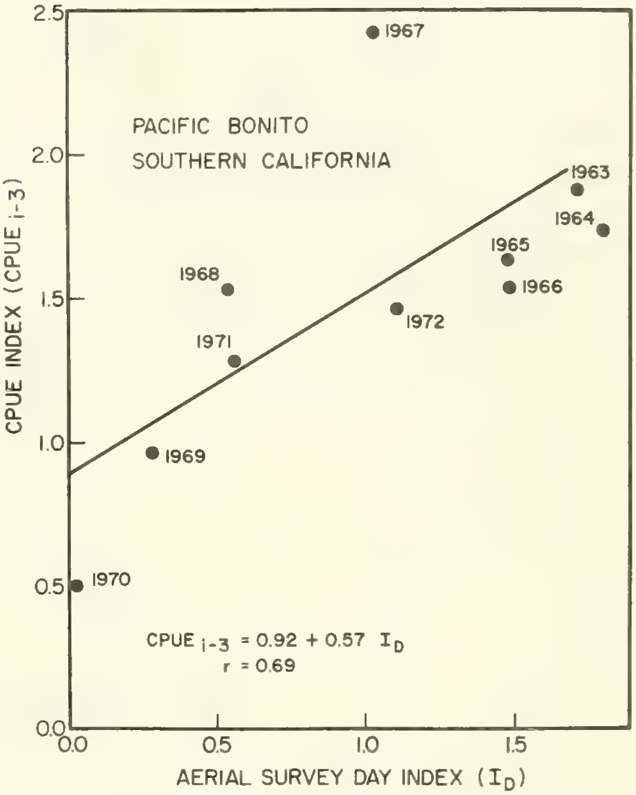

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Craig S. Nelson and David M. Husby

February 1983

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Climatology of Surface Heat Fluxes Over the California Current Region

CRAIG S. NELSON and DAVID M. HUSBY[1]

ABSTRACT

Historical surface marine weather observations are used to compute large-scale atmosphere-ocean heat exchange components over the California Current region. Heat exchange components are summarized by 1° square areas and long-term months, and major features of the monthly distributions are described. The accuracy of the derived air-sea interaction variables and methods of computation are discussed.

The region off the west coast of the United States and Baja California is characterized by net annual heat transfer from atmosphere to ocean. Net oceanic heat gain reaches a maximum during summer off Cape Mendocino. Near the coast, surface heat flux is determined by a balance between incoming solar radiation and effective back radiation. In the offshore regions, high cloudiness reduces the magnitude of the short-wave radiative flux, and latent heat flux produces the largest heat loss. The principal seasonal and spatial variations in air-sea heat transfer are a consequence of coastal upwelling which contributes to relatively low cloudiness and high incident solar radiation near the coast, suppression of evaporative heat loss, and reversal of the sensible heat flux. Simplified heat budget calculations demonstrate the importance of advective processes in maintaining the seasonal heat balance in coastal upwelling regions. Nonseasonal fluctuations are evident in time series of heat exchange processes, but low frequency components are not well described by the surface marine data used in this study.

INTRODUCTION

Eastern boundary current regions, such as the area off the west coast of the United States and Baja California, are characterized by high organic production which supports large stocks of commercially important fishes, e.g., Pacific sardine, *Sardinops sagax;* northern anchovy, *Engraulis mordax;* and Pacific mackerel, *Scomber japonicus.* High productivity is favored by vertical and horizontal transfer of nutrients and by a shallow thermocline that typically lies above the compensation depth in these temperate zones. Wind-forced divergence of surface flow is the principal driving mechanism for vertical nutrient exchange near the coast (Wooster and Reid 1963). Thermohaline processes modify the density structure and vertical stability of the upper ocean and partially condition these waters for high primary productivity. Internal readjustment of mass, in response to both thermal and wind forcing processes, may contribute to large-scale changes in circulation offshore and may alter the normal seasonal patterns of alongshore flow near the coast.

Comparative studies of surface circulation and reproductive strategies of pelagic fish stocks in the California Current suggest that nonseasonal fluctuations in atmosphere-ocean exchanges of momentum, heat, and mass lead to wide variations in recruitment to coastal fish stocks of the region (Parrish et al. 1981). Anomalous wind forcing may adversely affect larval survival by inducing loss of epipelagic eggs and larvae through strong seaward surface transport. Recent laboratory and field experiments have also suggested that reproductive success of the northern anchovy is sensitive to dispersion of food strata by wind mixing events during early larval feeding (Lasker 1978). The corollary implies that a precondition for enhanced larval survival may be strong vertical stability in the upper water column and the absence of vigorous mechanical wind mixing at the surface. Because stability is strongly affected by thermohaline processes, analyses of seasonal and nonseasonal atmosphere-ocean heat exchange processes may provide valuable indices to map favorable areas for larval survival.

Effects of climatic variability on stock recruitment have been observed in pelagic species in other eastern boundary currents, the North Sea, and the North Atlantic (Cushing 1975). Climatic change may be in the form of long-term fluctuations or year-to-year differences in the atmospheric forcing of the ocean. An important first step in modeling the fisheries-environment relationships in the California Current region is to determine the normal seasonal and spatial variability of the atmospheric forcing processes from which changes can be measured.

The California Current flows equatorward along the west coast of the United States between a cell of high atmospheric pressure to the west and a continental thermal low located over central California. Seasonal variations in the California Current appear to be related to fluctuations in wind stress and wind stress curl (Munk 1950; Reid et al. 1958; Hickey 1979). Nelson (1977) described the seasonal and spatial variations in wind stress and wind stress curl for the area off the west coast of the United States and Baja California. In addition to the wind-driven component of flow, a complete description of the California Current System must include the effects of atmosphere-ocean exchanges of heat and mass (evaporation – precipitation) on upper ocean circulation.

Summaries of large-scale heat exchange processes over the California Current have been made by Roden (1959) and Clark et al. (1974) based on monthly mean atmospheric properties within 5° latitude-longitude quadrilaterals. Wyrtki (1965) discussed the average annual values of heat exchange over the North Pacific Ocean north of lat. 20°S, computed from 2° square monthly mean atmospheric properties. The climate and heat exchange in a coastal upwelling region adjacent to the Pacific Northwest have been described by Lane (1965), who analyzed 11 yr of surface marine weather observations and computed monthly values of heat exchange components from 1953 to 1962. These summaries described the gross features of the large-scale heat exchange processes and characterized the region off the west coast of North America as an area of net annual oceanic heat gain. However, previous studies have not provided sufficient spatial resolution to delineate the critical areas of surface heat flux within the California Current region.

---

[1] Southwest Fisheries Center Pacific Environmental Group, National Marine Fisheries Service, NOAA, c/o Fleet Numerical Oceanography Center, Monterey, CA 93940.

In this report we present the long-term climatological monthly mean distributions of heat exchange across the air-sea interface based on a summarization of historical surface marine weather observations over the California Current region. This study differs from previous work for this area by calculating monthly mean values on a 1° latitude-longitude grid and by computing the heat exchange components from individual surface marine weather reports archived in the National Climatic Center's (NOAA, Environmental Data and Information Service) Tape Data Family-11 (TDF-11). Roden (1974) evaluated the surface radiative and turbulent heat fluxes on a 1° latitude-longitude grid. However, Roden's distributions were derived from monthly mean surface temperature and wind analyses and satellite cloud cover data based on a 5° latitude-longitude grid and interpolated to the finer mesh grid. We used standard bulk aerodynamic formulae, referred to a neutrally stable atmospheric boundary layer (Malkus 1962), to evaluate the evaporative and conductive heat fluxes. A separate analysis was performed to evaluate the dependence of these flux computations on the turbulent exchange coefficients as functions of windspeed and atmospheric stability. The methods are similar to procedures employed by Bunker (1976) and Hastenrath and Lamb (1978) for investigations of surface heat flux in the North Atlantic and in the tropical Atlantic and eastern Pacific Oceans, respectively. The distributions of heat exchange components described in this report will provide basic input data for a future simulation model of large-scale variations in the California Current ecosystem.

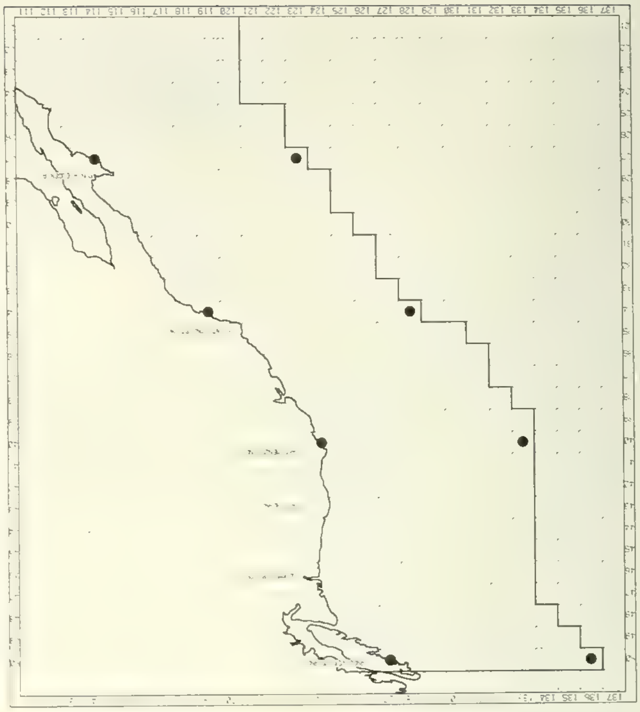

Figure 1.—Chart of the west coast of the United States showing the grid of 1° squares used for summaries of the surface heat fluxes. Large dots indicate squares for which the annual cycles of heat exchange processes are displayed in Figure 19.

PROCESSING OF DATA

Surface marine weather observations archived in the TDF-11 file consist of weather reports from teletype messages, ship logs, published ship observations, ship weather reporting forms, and various punched card decks obtained from foreign meteorological services. The sources of data and periods of coverage are tabulated in the TDF-11 documentation[2] and in Hastenrath and Lamb (1978). Over 1 million reports are within the California Current region and date from the mid-19th century through 1972. Individual reports were compiled by 1° squares within the geographical area outlined in Figure 1. The data grid extends from lat. 21°N to 50°N and parallels the coastline of British Columbia, the western United States, and Baja California. The grid extends 10° of longitude in the offshore direction, a distance ranging from 1,040 km at lat. 21°N to 717 km at lat. 50°N. Each 1° square is centered on a whole degree of latitude and longitude. Approximately 25% of the total available reports contain positions recorded to the nearest whole degree of latitude and longitude. The grid orientation used in this study reduces spatial bias which might be introduced by summarizing the data according to the more conventional Marsden square numbering system.

The observations contained in the TDF-11 reports vary markedly in methods and precision of measurement due to the changes in instrumentation and sampling techniques over the considerable time period covered by the data base. An individual surface weather report was used in the calculation of the heat exchange processes only if it contained all the properties needed to compute the radiative and turbulent heat fluxes. Values for surface pressure, P(mbar), sea surface temperature, T_s(°C); air temperature, T_a(°C); wet-bulb or dewpoint temperature, T_w or T_d(°C); windspeed, U_{10}(kn); and total cloud amount, C(oktas), were extracted from the TDF-11 file and quality controlled with a single pass editor to remove gross errors. Windspeed and cloud amount were converted to units of meters per second and tenths before incorporating these variables in the heat exchange formulae.

A total of 560,210 reports were accepted for the heat exchange calculations. These data amounted to 57% of the available reports. Approximately 38% of the reports were rejected because one or more of the surface meteorological observations were missing. An additional 3-5% of the reports were deleted because of duplicate reports and errors in position or because observed or derived variables could not pass specified climatic checks. An entire report was removed if surface observations exceeded the following extreme value limits: pressure (P) $<$ 945 mbar or $>$ 1,055 mbar; windspeed (U_{10}) $>$ 100 m/s; air temperature (T_a) $<$ -10°C or $>$ 40°C; wet-bulb temperature (T_w) $<$ -5°C or $>$ 40°C; sea temperature (T_s) $<$ -2°C or $>$ 35°C; and air-sea temperature difference (T_a-T_s) $<$ -30°C or $>$ 30°C. Wet-bulb and dewpoint temperatures were constrained to be less than or equal to the air temperature, and a valid estimate for total cloud amount (C), i.e., between 0.0 and 1.0, was required to accept the report. Cloud observations originally encoded as 9 (oktas) in the TDF-11 file indicated that the sky was obscured or cloud amount could not be determined. Consequently, these reports were also rejected. As a result of the editing procedures, the distributions of surface heat fluxes (Appendix I) and tables of monthly mean surface atmospheric properties (Appendix III) presented in this report are based on a common set of weather observations collected during the more restricted period from 1921 to 1972.

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[2] National Climatic Center, Tape Data Family 11, NOAA/EDIS/NCC, Asheville, NC 28801.

Empirical Heat Exchange Formulae

The net heat exchange across the sea surface, Q_N, is the sum of the direct and diffuse radiation from sun and sky reduced by cloud cover and sea surface albedo, Q_S, the net long-wave or effective back radiation, Q_B, the latent heat flux, Q_E, and the sensible heat flux, Q_C, as expressed in Equation (1):

$$Q_N = Q_S - Q_B - Q_E - Q_C \,. \tag{1}$$

Few direct measurements of radiative and turbulent heat fluxes have been made at sea. Observations of short-wave, long-wave, and net long-wave radiation have been analyzed by Tabata (1964), Charnell (1967), Reed and Halpern (1975), Reed (1977), and Simpson and Paulson (1979) for widely separated locations in the eastern and central North Pacific Ocean. Friehe and Schmitt (1976) and Anderson and Smith (1981) have reviewed the few available direct eddy flux measurements of sensible and latent heat. Because direct measurements of air-sea heat transfers are not routinely available over the ocean, the radiative and turbulent heat fluxes are commonly parameterized by empirical equations which incorporate empirically determined coefficients and regularly observed atmospheric properties at the sea surface and at some standard height above the sea surface. All empirically derived heat exchange components discussed in this report are expressed in units of watts per square meter.

Net incoming short-wave radiation from sun and sky, corrected for cloud cover and sea surface albedo, was calculated according to the following equation:

$$Q_S = (1-\alpha)Q_0\,(1-0.62C+0.0019h) \tag{2}$$

where α is the fraction of incoming radiation reflected from the sea surface, C is the observed total cloud amount in tenths of sky covered, and h is the noon solar altitude in degrees. The direct and diffuse radiation from a cloudless sky, Q_0, was obtained from an harmonic analysis of the values tabulated in the Smithsonian Meteorological Tables (List 1949) for an atmospheric transmission coefficient of 0.7 (Seckel and Beaudry 1973). Reed (1977) determined that estimates of clear-sky insolation computed from the Seckel and Beaudry formula differed from measurements of short-wave radiation under cloudless skies by 4% or less.

The reduction of solar insolation due to the presence of clouds has been estimated by various formulae ranging from linear (Kimball 1928) to cubic functions (Laevastu 1960) of total cloud amount, regardless of cloud type, or by relationships expressing a dependence on both cloud amount and cloud type (Lumb 1964; Seckel and Beaudry 1973). The linear cloud correction formula suggested by Reed (1977) was adopted in this study. The total cloud amount reports in the TDF-11 file represent visual estimates of the fraction of the celestial dome obscured by clouds. Such highly subjective observations frequently contain significant error and may not warrant using higher order cloud correction formulae.

The linear cloud correction in Equation (2) is appropriate for cloud cover ranging from 0.3 to 1.0. The reduction in insolation was neglected for cloud amounts < 0.25 (i.e., 2 oktas), a procedure recommended by Reed (1977), who also indicated that this formula results in a random error of estimate less than $\pm 10\%$ for estimates of monthly mean insolation and $\pm 20\%$ for weekly means. Reed's linear correction is similar to a formula derived by Tabata (1964) which was shown to give excellent agreement with radiation measurements at Ocean Weather Station "PAPA" (OWS-P) at lat. 50°N, where stratus type clouds predominate. Simpson and Paulson (1979) compared observations of incident solar radiation with predictions based on empirical formulae and demonstrated that Lumb's (1964) formula, which requires very reliable hourly observations of cloud amount and cloud type, was superior to Reed's linear correction formula for predictions averaged over 11 d. Predictions based on Reed's formula overestimated the 11-d mean incident solar radiation by 6%. The 11-d mean was 102.5 W/m^2, and the root-mean-square deviation between observations and predictions over the same 11 d, amounted to 16.7 W/m^2. Although cloud type observations are included in surface marine weather reports, we did not consider the additional cloud type information in the TDF-11 file to be sufficiently reliable to incorporate Lumb's more accurate formula in calculations of incident solar radiation.

Net short-wave radiation reaching the sea surface is the difference between incident solar radiation and the radiation reflected from the sea surface. Sea-surface albedo, α, was extracted from tables published by Payne (1972), as a function of atmospheric transmittance and mean daily solar altitude. Transmittance values were calculated by reducing the clear-sky atmospheric transmission coefficient of 0.7 used in this report by the linear cloud correction factor adopted from Reed (1977). In our calculations, albedo ranged from 0.04 in low latitudes during summer under cloudless skies to between 0.20 and 0.30 in higher latitudes during winter.

Effective back radiation is the difference between the outgoing long-wave radiation from the sea surface, proportional to the fourth power of the absolute sea surface temperature, and the incoming long-wave radiation from the sky, which depends on the water vapor content of the atmosphere and the type, density, and height of clouds. In this report we have adopted the modified Brunt equation (Brunt 1932) with the empirical constants of Budyko (1956) and the linear cloud correction formula of Reed (1976) to compute the net long-wave radiation:

$$Q_B = 5.50 \times 10^{-8}\,(T_S+273.16)^4(0.39-0.05e_a^{1/2})(1-0.9C). \tag{3}$$

The atmospheric vapor pressure, e_a(mbar), was computed from a formula given by List (1949:366) using the observed surface pressure, P, air temperature, T_a, and wet-bulb temperature, T_w. If any of the required variables were missing, but the dewpoint temperature, T_d, was present in the surface weather report, or if the archived wet bulb temperature was derived from a reported dewpoint temperature, as in TDF-11 Decks 110, 119, 185, 187, 196, and 281, then atmospheric vapor pressure was computed as the saturation vapor pressure at the dewpoint temperature using an integrated form of the Clausius Clapeyron equation (Murray 1967). In fewer than 12% of the reports, atmospheric vapor pressure was computed from the dewpoint temperature.

In previous studies of the large-scale surface heat flux in the eastern and central North Pacific Ocean (Roden 1959; Seckel 1970; Clark et al. 1974), effective back radiation was computed from the Berliand (Budyko 1956) formula which includes a nonlinear cloud factor and an additional term based on the air-sea temperature difference. Reed and Halpern (1975) demonstrated that the Berliand formula produces systematically higher values than those computed from the Brunt equation. Their estimates of net long-wave radiation predicted by Equation (3) were approximately 10 W/m^2 greater than measured daily mean values of 60-65 W/m^2 for two sites off the Oregon coast. Simpson and Paulson (1979) suggested that the formulae of Brunt and Berliand are equally satisfactory and may be used to predict daily values of net long-wave radiation with an absolute accuracy of 20 W/m^2.

The linear cloud factor in Equation (3) is appropriate for low stratocumulus clouds. Reed (1976) proposed an alternate linear correction (1–0.7C) which is more suitable for the higher clouds typical of the tropics. However, we could not discern any significant difference in seasonal cloud cover, by cloud type, which would allow us to use the alternate cloud factor in the lower latitudes of the study region.

The bulk aerodynamic formulae for turbulent fluxes of latent and sensible heat across the air-sea interface in a neutrally stable atmospheric boundary layer (Kraus 1972) can be expressed in the forms:

$$Q_E = \rho_a L C_E (q_0 - q_{10}) U_{10} \qquad (4)$$

and

$$Q_C = \rho_a c_p C_H (T_s - T_a) U_{10}. \qquad (5)$$

In these equations, ρ_a is the density of air, L is the latent heat of vaporization, c_p is the specific heat of air, C_E and C_H are experimentally determined exchange coefficients for water vapor and sensible heat, q_0 and q_{10} are the specific humidities of the air in contact with the sea surface and at 10 m or deck level, $T_s - T_a$ is the sea-air temperature difference, and U_{10} is the windspeed at 10 m or ship anemometer height. The equations are based on the assumption of a "constant flux" layer in the first few tens of meters above the sea surface, which allows the use of routine ship observations rather than measurements at the wave-perturbed, air-sea interface.

The specific humidities required in Equation (4) are not available in surface marine weather reports, but can be approximated from the relationship between specific humidity, q, and vapor pressure, e, expressed in Equation (6):

$$q \approx \epsilon \frac{e}{P}, \qquad (6)$$

where ϵ is a known constant ratio of the molecular weight of moist air to dry air, equal to a value of 0.622. We assumed constant values for density $\rho_a = 1.22$ kg/m^3, latent heat of vaporization, $L = 2.45 \times 10^6$ J/kg, and specific heat of air, $c_p = 1.00 \times 10^3$ J/kg per °C, and expressed the empirical exchange coefficients C_E and C_H, referred to the 10 m level, as constants equal to 0.0013 (Kraus 1972; Coantic 1974[3]; Anderson and Smith 1981). Substitution of these values and Equation (6), with $P = 1{,}013.25$ mbar, into Equation (4) yields the following formulae:

$$Q_E = 2.38(0.98 e_w - e_a) U_{10} \qquad (7)$$

$$Q_C = 1.59(T_s - T_a) U_{10}. \qquad (8)$$

The saturation vapor pressure over pure water at the sea surface temperature, e_w(mbar), was computed from a formula given by Murray (1967) and multiplied by 0.98 to account for the effect of salinity (Miyake 1952).

Long-term monthly mean heat exchange components were computed from all available reports between 1921 and 1972 within each 1° square area. The appropriate average is defined in Equation (9):

$$(\bar{Q}_S, \bar{Q}_B, \bar{Q}_E, \bar{Q}_C, \bar{Q}_N) = \frac{1}{n} \sum_{i=1}^{n} (Q_S, Q_B, Q_E, Q_C, Q_N)_i \qquad (9)$$

where n is the total number of reports within a particular 1° square area and month. The values $(Q_S, Q_B, Q_E, Q_C, Q_N)_i$ were evaluated according to Equations (2), (3), (7), (8), and (1), respectively. Each individual report was weighted equally. Therefore, the mean values of the heat exchange components for each long-term month and 1° square are formed from a data set which is independent of all other months and squares.

Monthly mean heat exchange fields are presented in Appendix I and include incident solar radiation corrected for cloud cover and reflection, $\bar{Q}_S$ (Charts 1 to 12); effective back radiation, $\bar{Q}_B$ (Charts 13 to 24); latent heat flux, $\bar{Q}_E$ (Charts 25 to 36); sensible heat flux, $\bar{Q}_C$ (Charts 37 to 48); and net heat exchange across the air-sea interface, $\bar{Q}_N$ (Charts 49 to 60). No attempt has been made to smooth the fields, either by removing data which do not appear to fit the distributions or by applying objective smoothing procedures. The mean heat exchange fields were contoured by computer, and "bull's-eyes" in the contours, even where they may reflect erroneous data, were left in the charts as indications of the general degree of consistency in the composite distributions.

Error Analysis

Errors associated with the computations of large-scale air-sea interaction transfers described in this report reflect 1) nonconformities in the spatial and temporal distributions of the surface marine observations, 2) inadequacies in data quality, and 3) uncertainties in the empirical heat exchange formulae. Random and systematic errors in the marine surface data primarily result from improper instrument calibration and measurement techniques, and inaccuracies introduced by data reduction at sea or in the process of archiving different data sets in the common TDF-11 format. These sources of error may introduce large variance in the monthly distributions of surface heat flux which might otherwise be interpreted as actual seasonal or nonseasonal variability related to geophysical processes.

The spatial distribution of the TDF-11 reports is known to be biased to coastwise and transoceanic shipping lanes between major seaports. Figure 2 shows the distribution of total numbers of observations per 1° square area used in this study for the calculation of heat exchange processes. The actual numbers of observations per month at each grid point are tabulated in Appendix II and shown as auxiliary data in Figures 3 and 4 for the months of July and December, respectively. The highest density of reports exists in a zone along the coast approximately 300 km wide. The largest numbers of reports are in the area of the Southern California Bight. The numbers of observations per 1° square per month ranged from 7 off the coast of Washington in December to more than 2,400 off Los Angeles in March, August, and October. The influence of merchant vessel traffic between San Francisco and Hawaii is evident in a zone approximately 200 km wide extending offshore, with more than 200 observations/mo per 1° square. Approximately 29% of the 1° squares contained fewer than 50 observations/mo, primarily reflecting the sparse distribution of weather reports between lat. 20°N and 30°N at distances > 400 km from the coast of Baja California. Nearly 40% of the long-term composite means were based on between 100 and 500 observations/mo. More than 500 observations/mo were available in 5% of the 1° squares.

Nonuniform distributions in time introduce additional bias in the sample statistics for the composite monthly mean heat exchange processes. Although all acceptable surface marine weather reports between 1921 and 1972 were used in this study, approximately 70 to 80% of the observations were collected after 1950. Therefore, the long-term mean values more properly represent estimates for

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[3] Coantic, M. 1974. Formules empiriques d'evaporation. Note de la Convention C.N.E.X.O./I.M.S.T. No. 74/951, 24 p., Xerox.

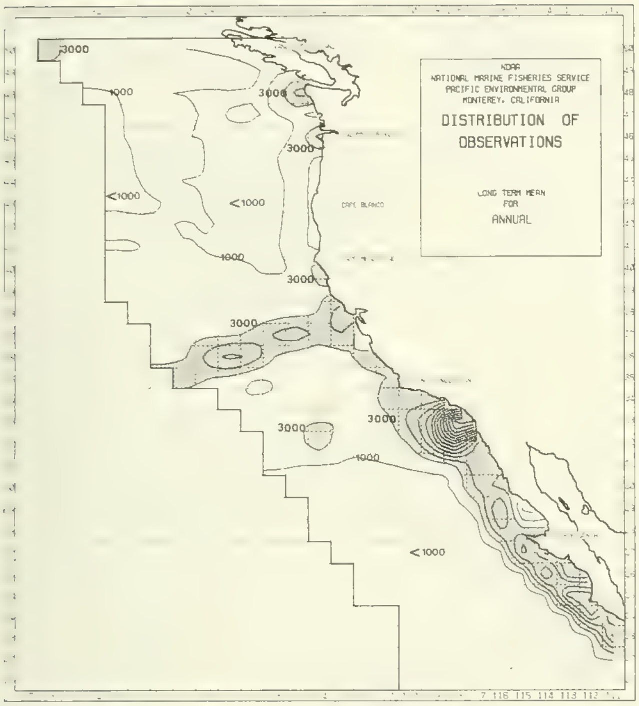

Figure 2.—Distribution of surface meteorological observations per 1° square. The contour interval is 2,000 observations. Values >3,000 are shaded.

the subpopulation extracted from the most recent 23 yr of data (1950–72). Seasonal bias is evident in a general tendency for fewer observations during winter than in summer, particularly in the 1° squares containing <100 observations/mo. The long-term means for June and July, for example, are based on approximately twice the number of observations as the mean values for December and January. However, along the shipping route from San Francisco to Hawaii, the summer means are based on from 10 to 20% fewer observations than the winter values. Within the relatively densely sampled coastal shipping lanes, the observations are approximately uniformly distributed in time, and exhibit only a slight tendency for the summer bias.

Inconsistency in the temporal and spatial sampling of surface atmospheric properties may introduce moderate to severe aliasing in the estimates of long-term monthly mean radiative and turbulent heat fluxes. Certain 1° square areas contained a disproportionately large number of observations per month with respect to the surrounding squares (Fig. 2). For example, the means for the 1° squares located at lat. 40°N, long. 124°W; lat. 46°N, long. 124°W; and lat. 48°N, long. 125°W were primarily based on 3-hourly surface observations collected at the Blunts Reef, Columbia River, and Umatilla Lightship stations from 1970 to 1972. We noted a greater than order of magnitude increase in the numbers of observations per year, from <100 to more than 1,000, at these locations beginning in 1970. According to Quayle[4], the lightship data, which may be of questionable quality, were not normally archived in the TDF-11 file and may have been included as the result of special contractual requests for these observations. Additional regions of dense spatial and temporal sampling at lat. 32°N, long. 124°W and lat. 50°N, long. 136°W exist as a result of the U. S. Navy radar picket ship program from 1960 to 1965. A particular consequence of these station-specific biases will be discussed in considering errors associated with computations of latent heat flux.

Areal averages of track-specific data, such as the TDF-11 reports, may be aliased if regions of relatively large spatial or temporal gradients are undersampled along narrow shipping lanes. It should be noted that this type of bias is not unique to the California Current region, and may be present in the summaries of Bunker (1976) and Hastenrath and Lamb (1978), who also used data from the TDF-11 file for computations of surface heat flux. Weare and Strub (1981) suggested that spatial and temporal biases in surface marine atmospheric data may contribute as much as 10% of the variance in long-term monthly mean flux estimates averaged over 5° squares. By averaging over 1° squares, we expect that the mean deviations resulting from spatial bias within a 1° square should contribute substantially <10% to the long-term variance. Temporal biases in the long-term monthly means caused by nonuniform sampling within a month or by strong diurnal variations in surface atmospheric properties, e.g., cloud cover, should be similar to the estimates calculated by Weare and Strub (1981). These biases may contribute the same order of magnitude variance as errors associated with random or systematic measurement and archiving errors and uncertainties in the bulk formulae.

Calculations of net short-wave radiation, Q_S, reflect uncertainties in the estimates for cloudless sky radiation and sea surface albedo and an inability to accurately parameterize the combined effects of cloud amount, type, height, thickness, and opacity on insolation. We previously discussed the errors in estimating insolation under clear-sky and cloudy conditions based on studies conducted by Reed (1977) and Simpson and Paulson (1979). The uncertainties in Payne's (1972) values for sea surface albedo range from <7% for solar altitudes >25° to 25% for low solar altitudes, and may contribute from <0.5 to 10% of the error in individual estimates of Q_S.

The monthly distributions of insolation discussed in this report are based on values computed from individual reports of total cloud amount. This procedure assumes that a single estimate of cloudiness, regardless of time of day, is representative of the daily mean cloud cover. Synoptic meteorological observations are usually reported at 0000, 0600, 1200, and 1800 Greenwich Mean Time (GMT), which correspond to 1600, 2200, 0400, and 1000 Pacific Standard Time (PST). Even if equal numbers of reports were available from all four synoptic periods, which is certainly not the case, one-half of the estimates of cloud amount would be from nighttime observations. Alternatively, if only daytime estimates of cloud amount were used, as suggested by Tabata (1964), then the number of observations would be reduced by a factor of 2 or more, because in certain 1° squares nighttime observations predominate.

If the distribution of cloud amount during a 24-h period is uniform, then either daytime or nighttime observations may be used to reliably estimate the mean daily cloud amount. However, Tabata (1964) and Weare and Strub (1981) have shown a tendency for daytime estimates of cloud cover to be 0.1 greater than nighttime estimates at OWS-P and for a 5° square near the coast of Baja California. Further difficulties in correcting insolation for cloudiness are caused by the primitive nature of observing and reporting from ships. Because observations of total cloud amount are reported in oktas, or in tenths converted to oktas, random errors of 0.125 (1 okta) in individual estimates of cloud amount can be expected. Reed (1977) also suggested the possibility of up to 0.20 positive bias in visual estimates of cloud cover in comparison with satellite-derived values. An error of 0.125 in the linear cloud factor in Equation (2) would produce errors in short-wave radiation ranging from 8 to 10% for cloud amounts <0.4 to 18% for total overcast. We estimate that the error in the long-term mean radiation

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[4] R. G. Quayle, Chief, Applied Climatology Branch, National Climatic Center, NOAA, Asheville, NC 28801, pers. commun. April 1981.

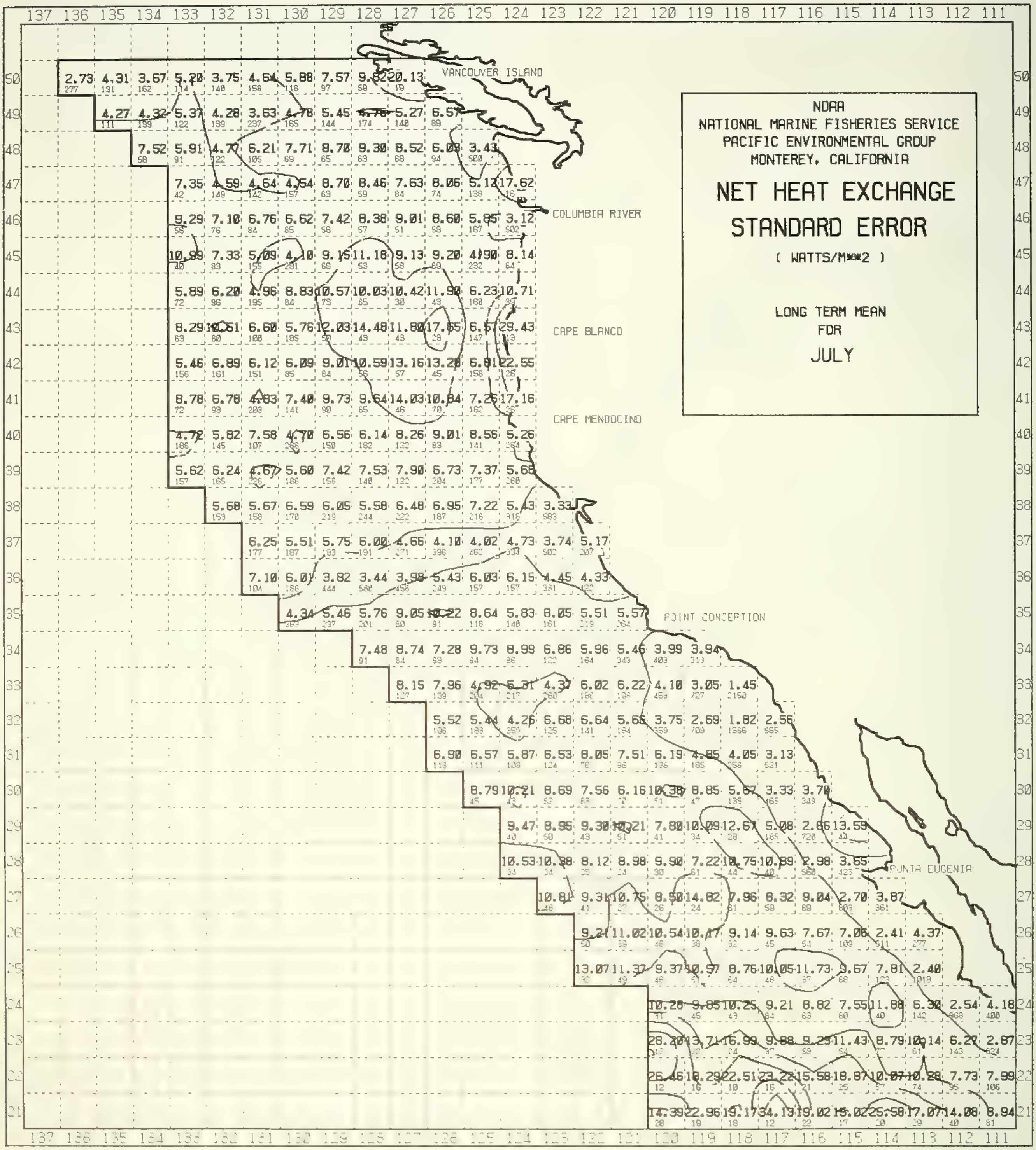

Figure 3.—Standard errors of the means and numbers of observations for July. The standard error of the mean for net heat exchange is plotted in units of W/m² and contoured at intervals of 5.0 W/m². The number of observations used to compute the monthly mean in each 1° square is displayed below the value for the standard error.

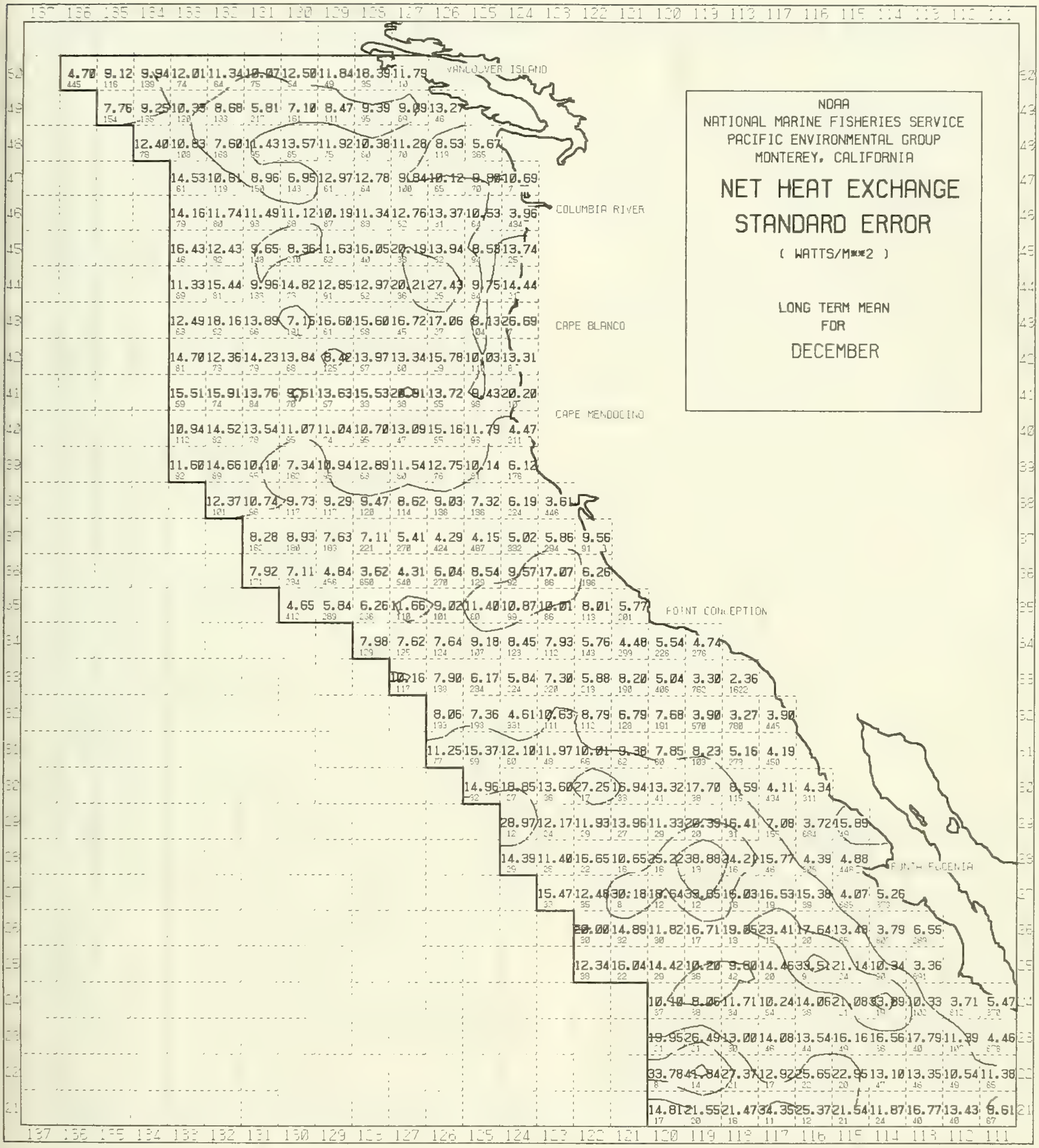

Figure 4.—Standard errors of the means and numbers of observations for December. The standard error of the mean for net heat exchange is plotted in units of W/m² and contoured at intervals of 10.0 W/m². The number of observations used to compute the monthly mean in each 1° square is displayed below the value for the standard error.

values shown in Appendix I (Charts 1-12) lies within 10% or approximately ±25 W/m^2 for typical summer values exceeding 250 W/m^2 in the 1° squares adjacent to the coast. Where the means are based on only a few observations per long-term month (i.e., fewer than 10), the uncertainty may be larger.

Most of the empirical formulae for computations of effective back radiation, Q_B, have been derived for overland conditions. Few verifications of the accuracy of the formulae have been made at sea. Comparisons between direct measurements of Q_B and predicted values based on Equation (3) in midocean and coastal regions established an upper bound on the accuracy of ±20 W/m^2 or approximately 20% of the observed daily mean net long-wave flux (Simpson and Paulson 1979; Reed and Halpern 1975).

The principal error in estimating Q_B again arises from uncertainties in the cloud correction term. However, net long-wave flux under clear skies may also depend on the distributions of temperature and humidity above the constant flux layer (Charnell 1967), which are not parameterized by the empirical formulae. The effect of neglecting humidity variations in the lower atmosphere may be comparable with that of variable cloud cover. Measurement errors in sea surface temperature, T_s, and near-surface vapor pressure, e_a, of 1°C and 1 mbar, respectively, contribute <3% to uncertainties in estimates of effective back radiation. However, an error of 0.125 (1 okta) in estimating total cloudiness introduces a relative error that ranges from <10% for low cloud amounts to more than 50% for high values of cloudiness. Thus, empirical formulae which have been derived for average conditions may not necessarily hold for estimates based on only a few observations. As the numbers of observations increase, the contribution of random errors will generally decrease, which suggests that the accuracy of the long-term mean net long-wave fluxes predicted from Equation (3) lies well within the 20% bound estimated by Simpson and Paulson (1979). In the California Current region, the loss of heat due to net long-wave flux varies from 20 W/m^2 offshore to 50 W/m^2 near the coast (Charts 13-24). The associated maximum errors would range from ±4 to ±10 W/m^2.

In western boundary current regions (Husby and Seckel 1975) and in the North Pacific trade wind zone (Seckel 1970), oceanic heat loss due to evaporative processes typically equals and often exceeds the heat gain due to incident solar flux. Along the west coasts of continents, however, latent heat flux is approximately the same order of magnitude as the effective back radiation, which is approximately a factor of 2 smaller than the incoming short-wave radiation. Near the west coast of the United States during summer, latent heat flux decreases by an order of magnitude and therefore may be more comparable in absolute magnitude with sensible heat flux. Although computations of latent heat flux from the bulk aerodynamic formula may contain large relative errors ranging from 20 to 60% (Clark 1967), the effect of data uncertainties on latent heat and net heat exchange computations may not be as serious as in the studies of Seckel (1970) and Husby and Seckel (1975).

The accuracy of latent and sensible heat flux computations is affected by uncertainties in the magnitudes of the experimentally determined turbulent transfer coefficients, C_E and C_H, and measurement errors in observations of sea, air, and wet-bulb temperatures and windspeed in the constant flux layer. Errors are also introduced if the assumptions which form the bases for the empirical formulae are not properly satisfied. Values of the neutral exchange coefficients referred to the 10 m level, as summarized by Friehe and Schmitt (1976), range from 0.0010 to 0.0016 with typical uncertainties of ±20%. Variations in atmospheric stability and the assumption that the transfer coefficients for heat and water vapor are equal and independent of windspeed, increase the uncertainty in the magnitudes of the derived turbulent exchange processes.

Bunker (1976) compared monthly averages of surface meteorological observations obtained from merchant vessels within subareas surrounding ocean weather stations (OWS) with corresponding means formed from the assumed higher quality OWS data. Based on comparisons using more than 500 observations, the 95% probability departures for air, sea, and dewpoint temperatures were 0.15°, 0.12°, and 0.27°C, respectively. In our study, 95% of the 1° square means are based on fewer than 500 observations/mo, and for 55% of the mean values, the numbers of observations are <100. The standard errors of temperature corresponding to these long-term means are 0.3°, 0.2°, and 0.5°C. For averages formed from <10 observations, uncertainties in the mean temperatures typically can be >1°C and may exceed 2°C.

The magnitudes of the errors vary as a function of instrument calibration, observing technique, and the reporting schemes used in the historical data files. For example, temperature values in Decks 110 and 281, U. S. Navy observations 1920-51, were originally recorded to the nearest whole degree Fahrenheit, and later converted to degrees and tenths Celsius; whereas the temperatures archived in Decks 118 and 119, Japanese ship observations 1937-60, were reported to the nearest whole degree Celsius. Therefore, the temperature values derived from these decks, which constitute 18% of the total observations, contain an additional uncertainty of ±0.5°C (Husby 1980). Because of large uncertainty in random sampling errors, we have not corrected observations of sea surface temperature for a possible systematic bias of 0.7°C in engineroom injection temperatures (Saur 1963) or measurements of air temperature and wet-bulb temperature which may be modified by ship-induced air flow distortion at the 10 m level (Holland 1972).

Temperature errors contribute directly to uncertainties in estimating sensible heat flux and indirectly affect calculations of latent heat flux by introducing errors in the sea-air vapor pressure difference. Average deviations of 0.2°C in sea-air temperature difference result in relative errors in sensible heat flux which decrease from 20 to 4% for temperature differences which increase from 1° to 5°C. A more characteristic temperature departure of 0.5°C introduces relative errors which decrease from 50 to 10% for similar sea-air temperature differences. For monthly mean sea-air temperature differences of 1°C and windspeeds of 6 to 7 m/s, errors of ±1 to ±5 W/m^2 may be expected for sensible heat fluxes of 10 W/m^2.

An error of 0.5°C in sea surface temperature results in errors in the saturation vapor pressure over water which vary from 0.4 mbar at 10°C to 1.0 mbar at 25°C. Comparable errors occur in estimates of vapor pressure of the air due to erroneous psychrometric measurements. Long-term mean sea-air vapor pressure differences over the California Current region generally lie between 1.0 and 5.0 mbar. However, in the area off southern Baja California during fall and winter, high sea surface temperatures and relatively colder and drier continental air combine to produce sea-air vapor pressure differences exceeding 15 mbar for individual observations. Mean differences are generally <10 mbar. Therefore, the possible error in computations of latent heat flux may be relatively large. For average deviations of 0.5 mbar, the uncertainty ranges from <4% for large vapor pressure differences to more than 40% at low values. The error associated with monthly mean values of $\bar{Q}_E$ between 50 and 100 W/m^2 would be approximately ±10 W/m^2.

In Equations (7) and (8), the vertical fluxes of heat and water vapor have been parameterized as a function of the observed windspeed, U_{10}. Nelson (1977) discussed the sources of error in wind reports in the TDF-11 data file and also determined that <12% of the total wind reports consisted of measured, as opposed to estimated, quantities. Approximately 35% of the reports from the California Current region consisted of Beaufort wind force estimates which were converted to equivalent 10 m windspeeds in knots and meters per second according to the international scale of 1946 (see List 1949:119). The standard deviation of the overall error of an estimated windspeed amounts to 0.58I, where I is the Beaufort interval (Verploegh 1967), and corresponds to ±0.7 to ±2.4 m/s for equivalent windspeeds of 0.9 m/s to 30.5 m/s. The remaining 53% of the observations were estimated windspeeds which did not agree numerically with the Beaufort wind force scale but typically were originally reported in 5-kn intervals for windspeeds >20 kn. Therefore, the possible error associated with these estimates is approximately ±1.3 m/s. An error of 1 m/s in estimating windspeed results in equivalent changes in the rates of evaporation and sensible heat transfer of 10 to 20% for the mean windspeeds of 5 to 10 m/s most commonly observed in the California Current region.

In using the historical surface marine weather reports, we have assumed that the wind observations were taken at a standard height of 10 m, or that the Beaufort force estimates were equivalent to windspeeds measured at this height. For surface winds which have been measured by shipboard anemometers, this assumption can be grossly inaccurate, since known anemometer heights vary from 7 to 37 m, the mean height being 21 m (Cardone 1969). If anemometer heights were known for the vessel reports comprising the 12% of the total observations which were measured as opposed to estimated quantities, a neutrally stable logarithmic wind profile could have been used to correct each observation from the measurement height to the 10 m reference level. Except for the relatively few anemometer heights from military and research vessels listed in Cardone's report, the anemometer heights for reports in the TDF-11 file cannot be readily determined. By assuming that windspeeds have been measured at 10 m, we possibly overestimate the turbulent fluxes by 12% for winds actually measured at 37 m and underestimate the fluxes by 3% for measurements taken at 7 m.

Conclusive verification of the derived rates of sensible and latent heat transfer and the associated accuracies of the bulk formulae has not been possible owing to the lack of extensive direct, over-water measurements of the temperature and moisture fluxes. On the basis of 30 eddy flux measurements of water vapor, Friehe and Schmitt (1976) concluded that latent heat flux is adequately described by the bulk formula (Equation (4)) with an uncertainty of 15 W/m^2 (standard deviation). The more numerous determinations of sensible heat flux also conform to the empirical equation with an uncertainty of approximately 3.8 to 8.4 W/m^2 (standard deviation). However, the direct measurements of sensible heat flux show a dependence on atmospheric stability and indicate a small positive flux of approximately 0.15 W/m^2, even when the value predicted from the term, $(T_s\text{-}T_a)U_{10}$, is zero. Although Laevastu's (1960) equation for the turbulent transfer of sensible heat predicts a nonzero flux for $U_{10}=$ 0 m/s (but not for $(T_s\text{-}T_a)=0°\text{C}$), the expected values from the more commonly used formula (Equation (5)) may include a 1 to 2% bias in addition to random measurement errors. The results of Anderson and Smith (1981) generally confirm the bulk formulae with uncertainties of ±10 to ±25%, and demonstrate the applicability of Equation (4) to negative fluxes of water vapor (i.e., condensation).

Equations (7) and (8) are generally used to parameterize the loss of heat from ocean to atmosphere due to evaporative and convective processes. The reverse processes of condensation and sensible heat transfer to the sea are also predicted by the formulae. Negative values of $(T_s\text{-}T_a)$ are commonly measured in eastern boundary current regions during periods when coastal upwelling establishes a stable atmospheric boundary layer. Comparable negative sea-air vapor pressure differences $(e_w\text{-}e_a)$ are not observed as often. Over large regions of the oceans, vapor pressure decreases with height, although the opposite behavior can occur over cold water areas (Roll 1965). Laevastu and Harding (1974) demonstrated a relatively rapid 5-h response of the properties of the surface air to changes in the properties of the sea surface. Therefore, in midlatitude and tropical regions away from coastal boundaries, the maximum atmospheric vapor pressure would be expected to correspond to the saturation vapor pressure at the sea-surface temperature, and evaporation would occur.

During spring and summer, modification of the atmospheric boundary layer by coastal upwelling processes produces stable stratification which is favorable for the formation of advection fog, particularly along the coasts of central and northern California and Oregon. When the contrast between warm, relatively moist air overlying a cooler sea surface is large, fog may persist even when the wind is strong. The resulting downward flux of water vapor transfers latent heat from atmosphere to ocean. A downward flux of moisture may also exist in a stable boundary layer in the absence of fog, as the data of Laevastu and Harding (1974) and Anderson and Smith (1981) demonstrate.

In a study of the heat exhange processes over the North Pacific trade wind zone, Seckel (1970) assumed that negative sea-air vapor pressure differences were due to erroneous observations of sea surface temperature, vapor pressure of the air, or both, and in such situations set the computed latent heat flux equal to 0. Over the California Current region, we found that 10% of the usable surface weather reports resulted in negative fluxes of latent heat. If these values were due to bad observations, then an approximately equal number of positive values should also be affected by poor quality observations, but we had no a priori reason to reject 20% of the data or possibly alias the long-term mean distributions by neglecting the rate of heat change through condensation, as Roden (1959) did in a previous study of the heat balance of the California Current region. However, additional quality control tests were implemented to remove unreasonably large negative and positive fluxes of both latent and sensible heat.

Editing procedures consisted of comparing observed surface properties with the average joint probability density functions of air-sea temperature difference versus windspeed and sea-air vapor pressure difference versus windspeed computed from the entire data set. Pairs of data values which fell outside a 1% bound of the joint probability density estimates were rejected. This method was relatively conservative, and <0.5% of the data was removed. The distributions could have been trimmed more severely. For example, in an earlier version of the flux calculations, we used Seckel's (1970) method and set the latent heat flux equal to zero for negative sea-air vapor pressure differences. Comparisons of the two sets of values showed that the ratio of the difference between the old and new values to the standard error of the mean of the recomputed data was consistently <1.0, except in regions within 200 km of the coast during months when coastal upwelling occurs. We concluded that our results would not be severely distorted by using Equation (8) for computing both positive and negative latent heat fluxes, and might be more representative of actual surface layer conditions near the coast.

Our computations indicate an upward flux of latent heat (Appendix I, Charts 25-36) over the entire California Current region except at lat. 40°N, long. 124°W in May, July, August, and September when the mean fluxes are -0.6, -11.0, -12.1, and -8.7 W/m^2, at lat. 41°N, long. 124°W in July and August (−6.0 and −0.4 W/m^2), and at lat. 43°N, long. 124°W in July (−18.2 W/m^2). Negative (condensation) values may be expected for periods of several hours to a few days; however, it seems unlikely that latent heat transfer from atmosphere to ocean would be characteristic in a long-term monthly mean sense.

Even though we may have correctly predicted the relative effects of condensation, the magnitudes of the computed values may be in error. When latent (and sensible) heat is transferred to the ocean, high stability of the air close to the sea surface greatly inhibits turbulent transfer, perhaps reducing the flux to $<10\%$ of the corresponding magnitude for comparable conditions in an unstable boundary layer. To test the effects of such a reduction, we recalculated the values for the 1° squares adjacent to the coast between Cape Mendocino and Cape Blanco and reduced the magnitudes by 90% when the computed latent heat fluxes were negative. The resulting long-term monthly means for the 1° squares and months indicated above remained small, but positive, being <10 W/m^2 in the mean.

Spatial and temporal biases also may have affected the calculations of latent heat flux. The long-term mean for July in the 1° square off Cape Blanco (lat. 43°N, long. 124°W) was computed from only 13 observations, of which nine values resulted in negative fluxes of latent heat. South of Cape Mendocino, observations from the Blunts Reef Lightship station consistently biased the long-term means by effectively weighting the computed fluxes for 1970 and 1971 by an order of magnitude more than for any other year. By removing the lightship data, the negative values of latent heat flux which appear at this location during summer (Chart 29 and Charts 31-33) could have been removed, and for July the mean value would have changed from -11.0 W/m^2 (condensation) to +5.5 W/m^2 (evaporation). Although we recognized that these biases existed, no attempt was made to systematically remove observations from those areas where densely sampled station data were apparent.

There are very few direct measurements of negative fluxes of water vapor (latent heat) and none which support a large reduction in the transfer across the air-sea interface under stable conditions. The data reported by Anderson and Smith (1981) suggested only a 12% and at most a 50% reduction in the transfer process (see their equations (7) and (8)) in a stable as opposed to an unstable boundary layer, for comparable values of moisture flux. Although the magnitudes of latent heat flux remain somewhat in doubt, our computations indicate that heat losses due to evaporation from the sea surface make a relatively unimportant contribution to the oceanic heat budget during summer in regions adjacent to the coast.

The net heat exchange across the sea surface, Q_N, is the difference of large numbers. Therefore, the uncertainty in Q_N may be substantially greater than the errors for the individual exchange processes. For example, during July off Monterey, Calif., the average value of $\bar{Q}_N$ is 197 W/m^2. Conservative estimates of the errors in $\bar{Q}_S$(10%), $\bar{Q}_B$(10%), $\bar{Q}_E$(15%), and $\bar{Q}_C$(15%) result in a relative error of 17% in the estimate for $\bar{Q}_N$. At the same location in December, the error in $\bar{Q}_N$ increases to 64% for a long-term mean value of -36.7 W/m^2.

The accuracy of each of the long-term monthly mean heat flux components was independently estimated by computing the standard error of the mean defined by:

$$SE_{\bar{Q}} = SD_Q/\sqrt{n} \qquad (10)$$

where $SE_{\bar{Q}}$ is the standard error of the mean for each heat exchange component (i.e., $\bar{Q}_S$, $\bar{Q}_B$, $\bar{Q}_E$, $\bar{Q}_C$, $\bar{Q}_N$), SD_Q is the corresponding sample standard deviation, and n is the number of observations. Large values of n and small values of SD_Q correspond to mean values $\bar{Q}$ which closely approximate the population means. Although the computed standard errors reflect observational noise as well as nonseasonal variability, the distributions of $SE_{\bar{Q}}$ provide an overall view of the reliability of the long-term monthly heat flux estimates.

Standard errors of the means and the numbers of observations in each 1° square area and long-term month are tabulated in Appendix II. The standard errors are largest for $\bar{Q}_E$ and $\bar{Q}_S$ and smallest for $\bar{Q}_C$ and $\bar{Q}_B$. The resulting standard errors of the means for $\bar{Q}_N$,($SE_{\bar{Q}_N}$), range from 1.3 W/m^2 at lat. 33°N, long. 118°W in September ($n=2{,}259$) to 57.6 W/m^2 at lat. 22°N, long. 120°W in June ($n=9$). Distributions of minimum and maximum values of $SE_{\bar{Q}}$ generally conform to the pattern of observations shown in Figure 2.

The net heat exchange standard errors and the numbers of observations for July and December, respectively, are mapped in Figures 3 and 4. Minimum values of $SE_{\bar{Q}_N}$ coincide with the coastwise shipping lanes stretching from southern Baja California to Point Conception and with the transoceanic track between San Francisco and Hawaii. In the extreme northwest section of the grid, steady westerly winds and minimum sea-air vapor pressure differences contribute to low values of $SE_{\bar{Q}_N}$ in July (Fig. 3). Within these regions, the 95% probability of departure from the population mean is <10W/m^2.

High values of $SE_{\bar{Q}_N}$ occur along and offshore from the coast between Cape Mendocino and Cape Blanco (Fig. 3) and in the southwest section of the grid, and are associated with regions of sparse data, although sporadic sampling of intense winter storms may also lead to large values (Fig. 4). Values between 5 and 10 W/m^2 occur throughout a large portion of the summary area in July. In the offshore regions from lat. 21°N to 31°N and from lat. 40°N to 50°N, 95% probability departures frequently exceed 30 W/m^2 in December. Typical ratios of the standard error to the mean net heat exchange ($SE_{\bar{Q}_N}/\bar{Q}_N$) range from 0.01 to 0.27 in July, the average ratio being 0.05. In December, large values of $SE_{\bar{Q}_N}$ and small values of $\bar{Q}_N$ result in ratios which vary in absolute magnitude from 0.04 to 34.8, with an average value of 0.71.

In areas outside of the primary shipping lanes, monthly mean distributions of $\bar{Q}_N$ are based on approximately equal numbers of observations per 1° square. If there are no systematic sampling errors, then the relative magnitudes of the computed standard errors of the means should be related to the spatial and temporal variability in $\bar{Q}_N$. Figures 3 and 4 indicate a slight tendency for larger values of $SE_{\bar{Q}_N}$ in the northern section of the grid than in the southern area. The seasonal contrast is more apparent. The greater variability associated with winter surface atmospheric properties contributes to values of $SE_{\bar{Q}_N}$ which are 50 to 100% larger in December (Fig. 4) than in July (Fig. 3), which indicates that a large part of the monthly variance in $\bar{Q}_N$ may be due to actual intramonth fluctuations rather than observational errors.

Limits on the absolute accuracy of the empirically derived heat transfers have not been well established by experimental data. Nevertheless we feel that the general coherence of the values mapped in Appendix I demonstrates that the fields are representative of the expected spatial and seasonal variability over the California Current region. Small-scale features and detail within a single 1° square area which are not supported by similar values in surrounding squares probably reflect observational "noise" and should be viewed with caution. Smoother distributions could have been produced by taking averages over 2° or 5° square areas as Wyrtki (1965) and Roden (1959) have done. However, 1° square resolution was retained to preserve detail in the distributions of the individual heat exchange processes, particularly within 300 km of the coast. The fine spatial resolution may be less meaningful for the offshore regions where the decrease in the number of observations per averaged value increases the uncertainty in the derived quantities.

DEPENDENCE OF HEAT EXCHANGE ESTIMATES ON COMPUTATIONAL METHODS

The procedures followed in this study involved computations of the heat exchange processes for each weather report, which were then averaged to form the long-term monthly mean values. Constant exchange coefficients, C_E and C_H, were used in Equations (4) and (5) to estimate the turbulent fluxes of latent and sensible heat. Different results might have been obtained if the radiative and turbulent fluxes had been calculated from monthly mean atmospheric properties or if the transfer coefficients for the turbulent fluxes had varied with windspeed or atmospheric stability. These aspects are discussed below.

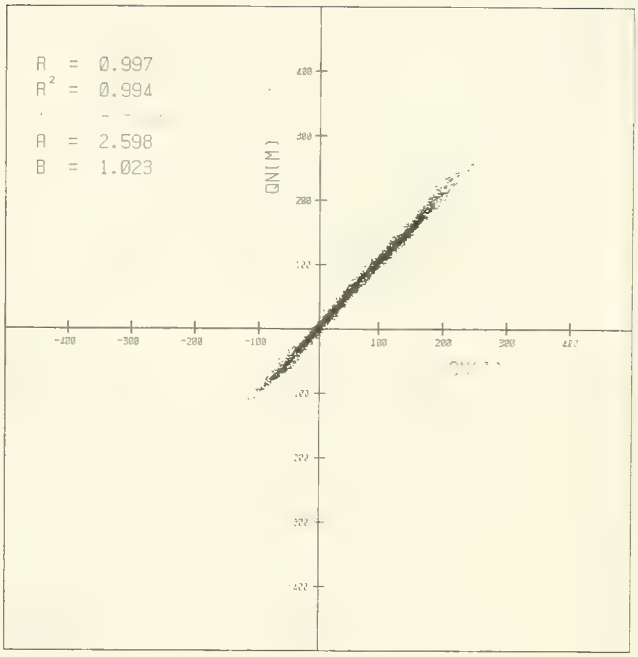

Figure 5.—Linear regression of monthly net heat exchange values computed from mean monthly meteorological properties, $Q_N(M)$, versus monthly net heat exchange computed from individual reports, $Q_N(I)$. Units are W/m². The correlation coefficient is $R = 0.997$ and the coefficient of determination is $R^2 = 0.994$. The dashed diagonal line represents the regression equation $Q_N(M) = 2.598 + 1.023\, Q_N(I)$.

Exchange Processes Computed from Monthly Mean Atmospheric Properties

Previous summaries of large-scale heat exchange processes have used mean monthly values of atmospheric and oceanic properties in the empirical formulae, primarily due to the lack of sufficient data to perform the calculations on shorter time scales. Malkus (1962) has shown that the use of mean monthly values can lead to underestimates of the turbulent heat fluxes. For the sake of comparability, we have assembled long-term monthly mean atmospheric properties (Appendix III) and used these values to recompute the heat exchange components.

Figure 5 shows a scatter diagram of all monthly gridpoint values of net heat exchange computed using mean monthly properties, $Q_N(M)$, versus the mean monthly net heat exchange computed from the individual synoptic weather reports, $Q_N(I)$. The slope of the least-squares regression of $Q_N(M)$ on $Q_N(I)$ is 1.02 and the coefficient of determination (R^2) between the two data sets is 0.99. Because the correlation for this regression may be artificially inflated by the seasonal cycle in both data sets, linear regressions were computed by month for each of the heat exchange components. Table 1 lists the coefficients of determination, significant above the 99% level, and slopes of the regression lines, each of which is based on 300 pairs of observations.

The mean heat transfers computed from the individual surface weather reports show a high degree of correlation with those computed from mean monthly atmospheric and oceanic properties. The highest correlations are found for $\bar{Q}_B$ and $\bar{Q}_S$ ($R^2 > 0.99$). The regressions for $\bar{Q}_C$ show the lowest correlations and the greatest degree of seasonal variability ($0.88 < R^2 < 0.96$).

The slopes of the regression lines provide an estimate of the average differences between values of the radiative and turbulent fluxes computed by the two methods. The largest deviations occur for incident solar radiation. The monthly values, $Q_S(M)$, are from 1 to 18% larger than corresponding estimates, $Q_S(I)$, based on synoptic reports. A similar relationship between $Q_S(M)$ and $Q_S(I)$ has been demonstrated by Seckel (1970) and Husby and Seckel (1975). The correlations for latent and sensible heat exchange show that computations which use monthly mean properties consistently underestimate the turbulent fluxes by 1 to 8% for $\bar{Q}_E$ and 3 to 13% for $\bar{Q}_C$, although in August, September, and October, the $Q_E(M)$ values are approximately 1% larger than $Q_E(I)$. These differences are comparable with values of about 7% discussed by Malkus (1962) and are within the uncertainties of the determinations discussed earlier.

Estimates of net heat exchange computed by the two methods are well correlated ($0.95 < R^2 < 0.98$). Slopes > 1.0 indicate that the values based on monthly parameters, $Q_N(M)$, are consistently more positive than the monthly averages of individual estimates, $Q_N(I)$, although this generalization is not valid for all areas in all months. Distributions of the ratio $Q_N(M)/Q_N(I)$ are shown in Figures 6 and 7 for July and December, respectively. In July the values for $Q_N(M)$ are approximately 3% greater than those for $Q_N(I)$, except near the coast of southern Baja California, between Point Conception and Cape Blanco, and off Vancouver Island. The use of long-term monthly mean atmospheric properties results in 5 to 10% higher oceanic heat gain in these regions compared with the monthly means of synoptic estimates. During December, the ocean loses heat over the entire California Current region (Chart 60). Values of $Q_N(M)/Q_N(I) < 1.0$ occur over approxi-

Table 1.—Monthly values of coefficient of determination (R^2) and slope (B) of regression line for linear regressions between heat exchange components ($\bar{Q}_S$, $\bar{Q}_B$, $\bar{Q}_E$, $\bar{Q}_C$, $\bar{Q}_N$) estimated from monthly mean atmospheric properties, $Q(M)$ and those computed from individual reports, $Q(I)$.

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Q_S	R^2	0.998	0.997	0.993	0.991	0.991	0.991	0.994	0.989	0.990	0.995	0.998	0.999
	B	1.016	1.028	1.051	1.079	1.164	1.181	1.156	1.096	1.056	1.036	1.021	1.009
Q_B	R^2	.997	.998	.998	.997	.998	.998	.999	.998	.996	.995	.997	.997
	B	1.003	1.000	1.003	1.003	.995	.993	.992	.989	.987	1.010	1.004	.996
Q_E	R^2	.954	.968	.975	.986	.986	.980	.974	.962	.971	.972	.970	.963
	B	.929	.923	.961	.988	.987	.985	.988	1.022	1.007	1.012	.961	.926
Q_C	R^2	.934	.881	.927	.924	.945	.955	.963	.955	.948	.931	.941	.909
	B	.953	.865	.939	.946	.966	.953	.944	.966	.926	.943	.960	.926
Q_N	R^2	.970	.957	.958	.952	.956	.963	.979	.958	.962	.974	.980	.965
	B	1.018	1.029	1.048	1.086	1.049	1.085	1.121	1.091	1.067	1.022	1.025	1.017

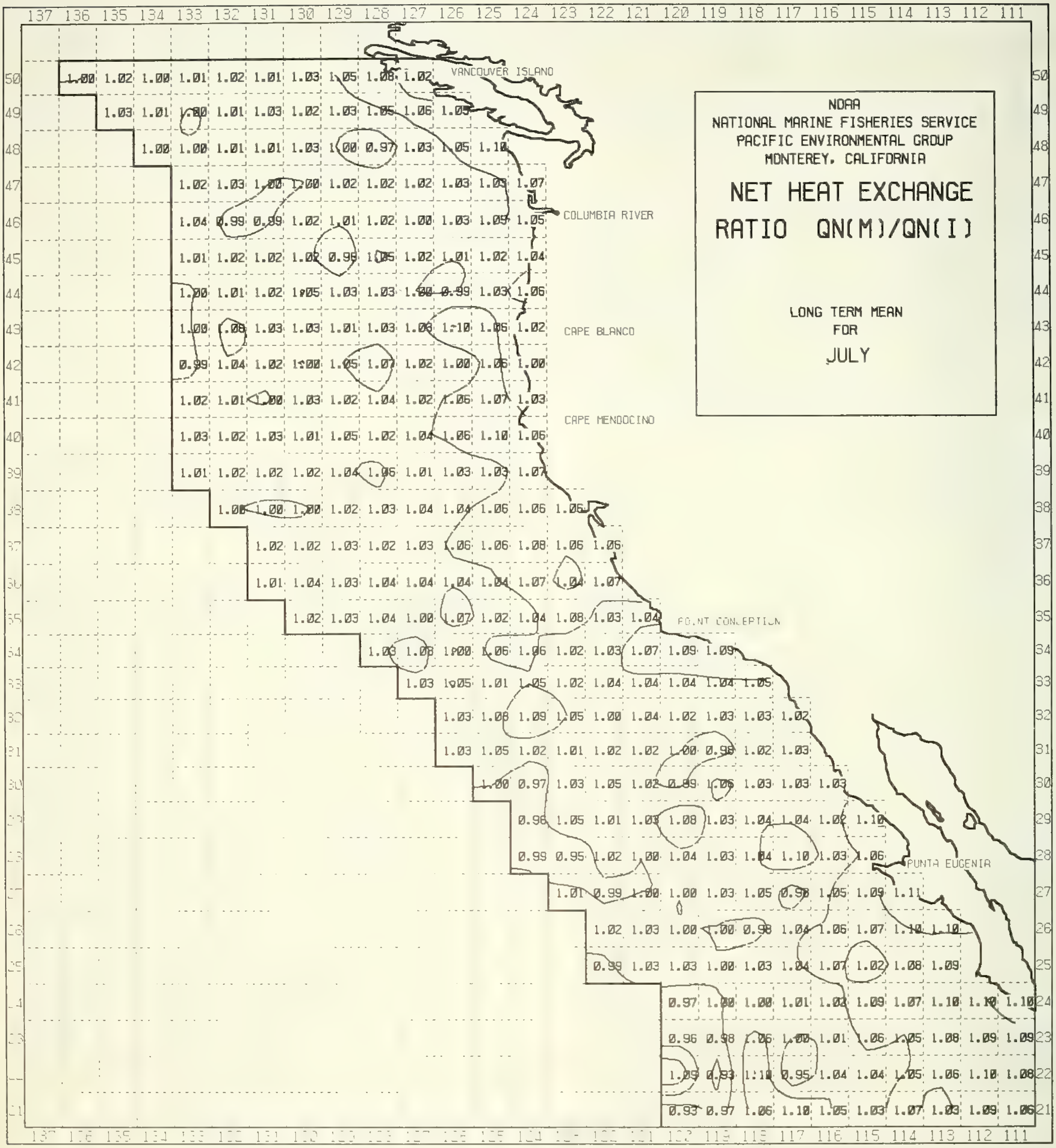

Figure 6.—Spatial comparison of net heat exchange values for July, estimated from mean monthly surface meteorological properties, $Q_N(M)$, versus that computed from individual reports, $Q_N(I)$. The nondimensional ratio $Q_N(M)/Q_N(I)$ is plotted and contoured at intervals of 0.05.

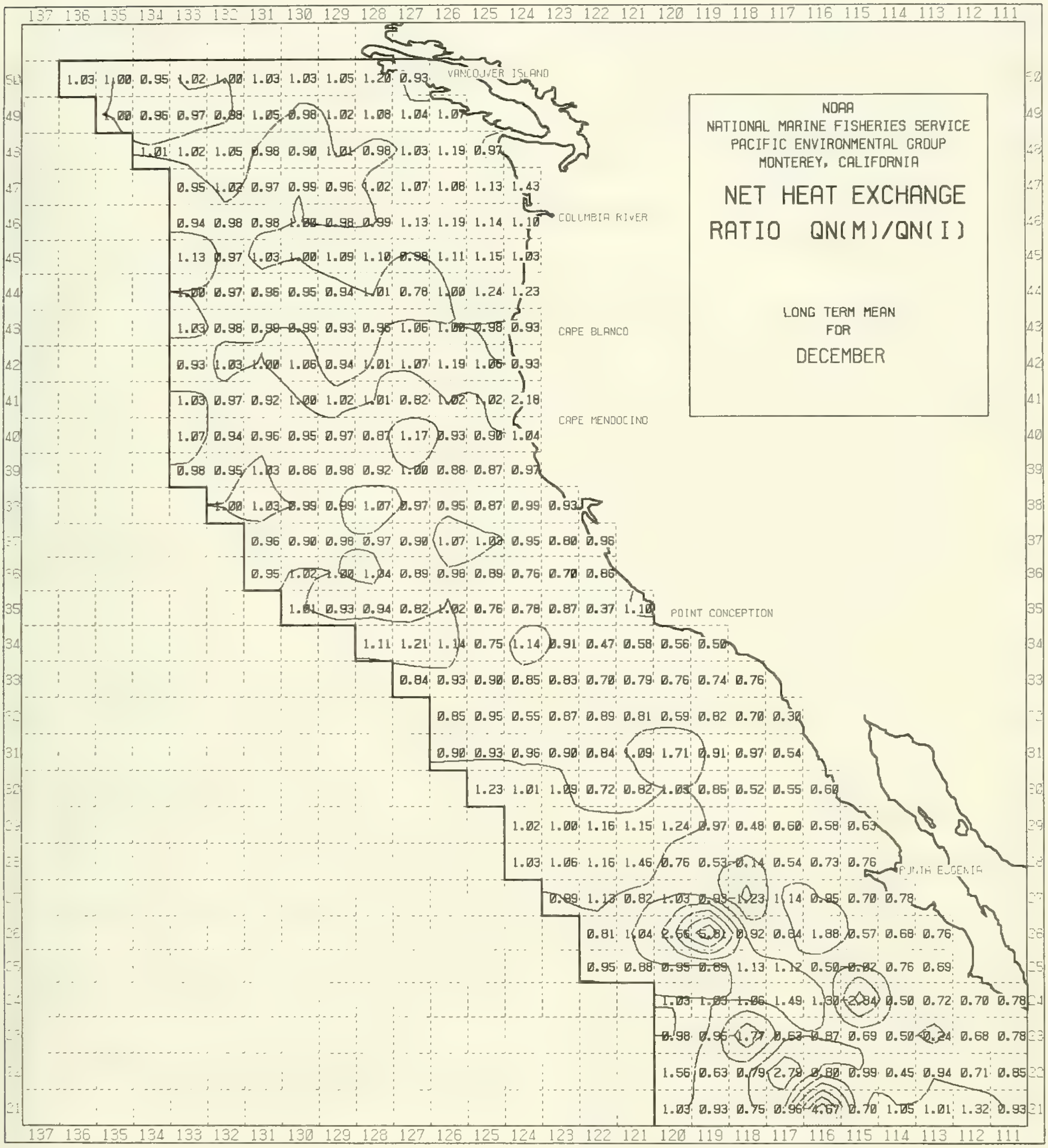

Figure 7.—Spatial comparison of net heat exchange values for December, estimated from mean monthly surface meteorological properties, $Q_N(M)$, versus that computed from individual reports, $Q_N(I)$. The nondimensional ratio $Q_N(M)/Q_N(I)$ is plotted and contoured at intervals of 1.0.

mately 60% of the data grid (Fig. 7) and imply less oceanic heat loss for the flux estimates computed from monthly mean variables. Higher heat loss would be expected over a large area adjacent to the Pacific Northwest. The high linear correlations between heat exchange components estimated from monthly mean atmospheric properties and those computed from synoptic reports imply that the principal spatial and temporal patterns evident in the charts in Appendix I are independent of the averaging methods used to compute the monthly mean fluxes.

Effects of Variable Exchange Coefficients

The empirical formulae which have been applied to studies of large-scale turbulent latent and sensible heat transfer vary primarily in the form of the exchange coefficients which have been used. In the derivations of the bulk aerodynamic formulae, it is usually assumed that the coefficients C_E and C_H are constants, approximately equal to the drag coefficient, C_D, for momentum transfer (Roll 1965). For example, Kraus (1972) suggested the value $C_E = C_H = C_D = 0.0013$. In recent years, however, a great deal of effort has gone into the determination of these bulk exchange coefficients and their dependence on windspeed, atmospheric stability, and the aerodynamic roughness of the sea surface as a function of the spectral shape of the ocean wave field (Davidson 1974). Until these coefficients have been accurately determined for all combinations of stability, windspeed, and sea conditions, the bulk exchange formulae are best regarded as dimensionally correct parameterizations which need further experimental verification (Pond 1975).

Busch (1977) discussed the results of recent research and described the work of Friehe and Schmitt (1976), who compiled data from several sources, including their own, and found that the exchange coefficient for the turbulent flux of latent heat was well described by $C_E = 1.32 \times 10^{-3} \pm 0.07 \times 10^{-3}$. The coefficient for sensible heat transfer could be approximated by $C_H = 1.41 \times 10^{-3} \pm 0.02 \times 10^{-3}$ over wider ranges of windspeed and sea-air temperature differences. Their analyses suggested that the coefficient, C_E, was constant and larger than that for sensible heat transfer, C_H, for equivalent windspeeds, and demonstrated a dependence of C_H on atmospheric stability and windspeed. An extensive review of comparable data for momentum transfer (Garratt 1977) substantiates the windspeed dependence for the drag coefficient, C_D. The dependence of the transfer coefficients on atmospheric stability has been predicted by Deardorff (1968). Based on theoretical considerations and a review of experimental data, Coantic (footnote 3) recommended the values, $C_E = C_H = 1.3 \times 10^{-3}$ for windspeeds < 10 m/s and $C_E = C_H = (1.0 + 0.05 U_{10}) \times 10^{-3}$ for the range, $0 < U_{10} < 20$ m/s. Eddy flux measurements discussed by Anderson and Smith (1981) indicated a positive windspeed dependence for the neutral evaporation coefficient, $C_E = (0.55 + 0.083\ U_{10}) \times 10^{-3}$, for windspeeds of 5 to 11 m/s. No dependence of C_E on atmospheric stability was observed, although this result may have been influenced by the lack of numerous direct measurements in stable conditions. The corresponding temperature flux data showed a 40% increase in the coefficient for sensible heat transfer from $C_H = 0.82 \times 10^{-3}$ in a stable boundary layer to $C_H = 1.12 \times 10^{-3}$ for unstable conditions. Because there is large scatter in open ocean determinations of C_E and C_H, lack of agreement among individual observers, and a tendency for uncertainties in the flux estimates introduced by errors in the observed atmospheric properties to be larger than errors caused by variations in the exchange coefficients, we assumed identical and constant values for C_E and C_H in this study.

To investigate the possible effects of variable exchange coefficients on the turbulent transfer processes, the monthly mean fields of latent and sensible heat flux have been recomputed, and the constant values C_E and C_H in Equations (4) and (5) were replaced by coefficients which varied with windspeed and atmospheric stability. The linear relationship proposed by Coantic (footnote 3) was used to define the windspeed dependence of C_E and C_H, and Deardorff's (1968) empirical expressions, which are functions of the bulk Richardson number $(Ri)_B$, were adopted to parameterize the dependence of the exchange coefficients on stability. Neutral stability was assumed when the absolute value of the air-sea temperature difference was < 1°C and the available data were further reduced by restricting the calculations to the range $-0.2 < (Ri)_B < 0.1$. In the following discussion we consider only the calculations for latent heat flux. Complete details will be reported elsewhere.

The combined effect of windspeed and atmospheric stability was computed as a percentage increase (decrease) in the magnitude of the monthly mean latent heat flux above (below) the corresponding value computed with a constant coefficient. Values corresponding to the percentage differences for June and December, respectively, are displayed in Figures 8 and 9. In June, the average percentage increase is between 10 and 15%, although in the region of the wind stress maximum between Point Conception and Cape Blanco (Nelson 1977), the computed increase may be larger than 25%. The corresponding evaporative heat loss increases from approximately 45 to 56 W/m^2. The winter distribution (Fig. 9) shows an alongshore gradient. South of Point Conception the average percentage increase is approximately 15%, while in the region adjacent to the Pacific Northwest differences $>40\%$ might be expected.

The principal difference between estimates of latent heat flux computed with a variable as opposed to a constant exchange coefficient, C_E, is caused by the windspeed dependence of C_E. Additional analyses were performed to identify the relative effects of atmospheric stability and windspeed. The results for June suggest a 10 to 20% increase in latent heat transfer due to the dependence of C_E on windspeed. Stability effects account for $<5\%$ of the overall change. Higher windspeeds and unstable conditions associated with transient winter storms produce larger differences. Stability effects account for a 10 to 15% increase in latent heat flux during winter, and the windspeed dependence of C_E contributes between 5 and 25% of the difference. The relative differences between estimates of latent heat flux computed with a constant exchange coefficient as opposed to a coefficient which depends on windspeed and stability, are larger than values of $<5\%$ reported by Dorman et al. (1974) at OWS-N, but more consistent with increases of 6 to 15% discussed by Husby and Seckel (1975) for OSW-V and with results for the North Pacific trade wind zone described by Seckel (1970).

SEA LEVEL OCEAN-ATMOSPHERE PROPERTIES AND THEIR SEASONAL VARIABILITY

The predominant factors influencing the seasonal variations in the air-sea interaction processes of the California Current region are the seasonal movements and changes in intensity of the subtropical high pressure system and the continental low pressure system and variations in the properties of the waters of the California Current. The variations in the atmospheric pressure centers modify the surface wind field and the distribution of cloud cover, and, through the action of the surface wind stress, induce upwelling at the coast during summer. Upwelling has a marked effect on the climate along the west coast of North America (Smith 1968).

Figure 10 shows the average monthly sea level atmospheric pressure distributions over the eastern North Pacific Ocean and the west coast of

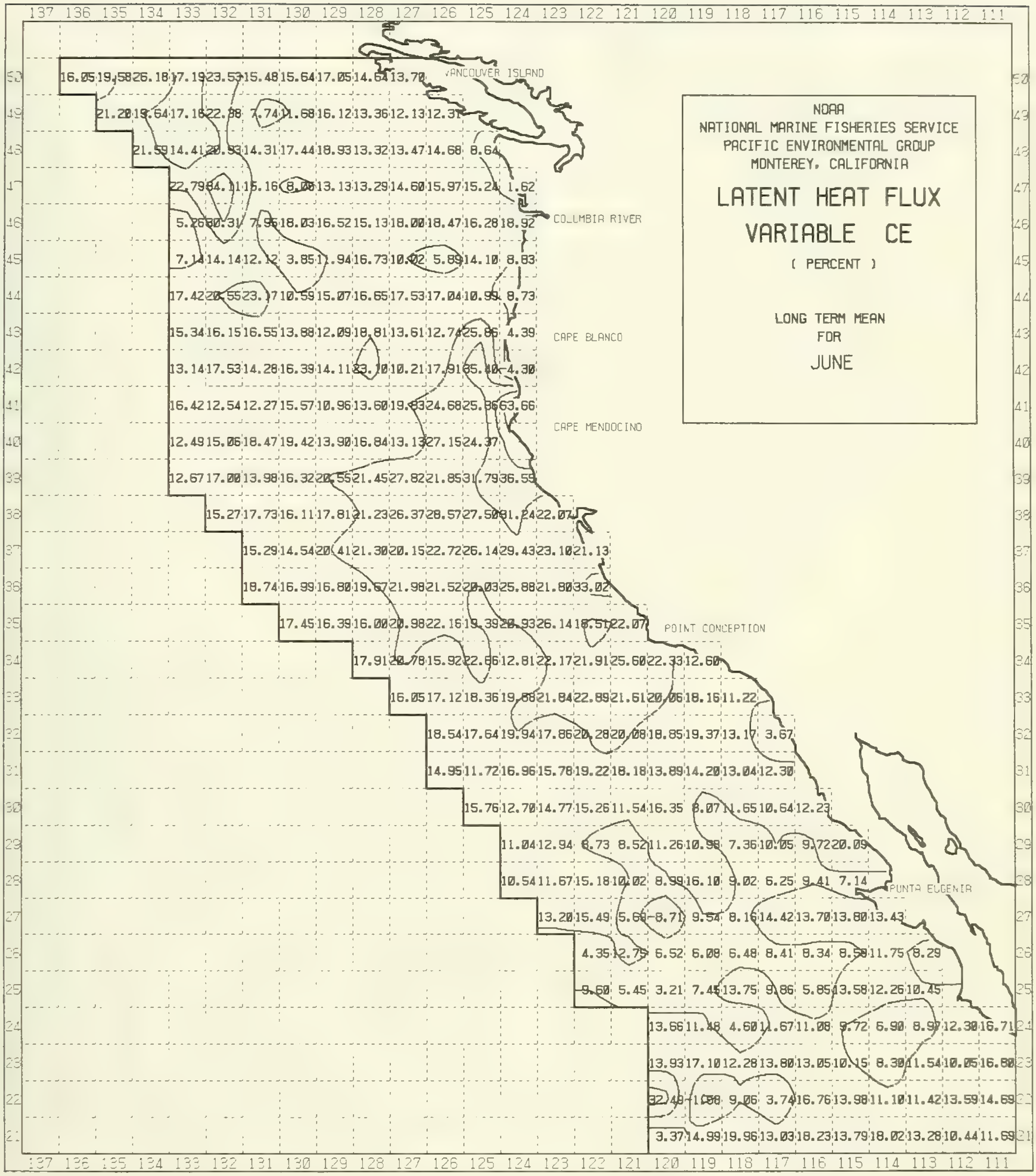

Figure 8.—The effect of a variable exchange coefficient (C_E) on computations of latent heat flux (Q_E) for June. Plotted values are the percentage increase (decrease) in latent heat flux above (below) that computed with a constant exchange coefficient. The contour interval is 10.0. Negative values are shaded.

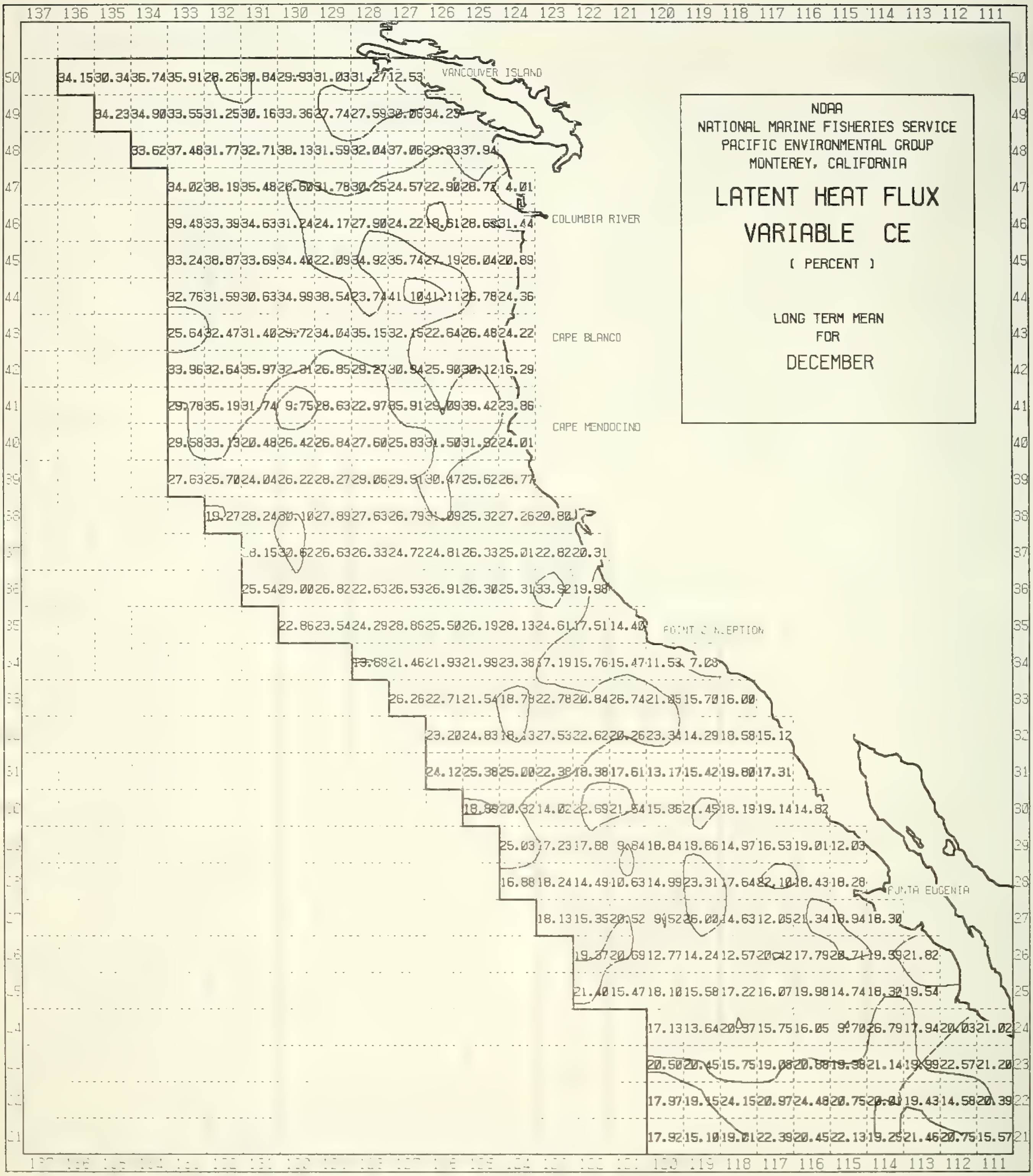

Figure 9.—The effect of a variable exchange coefficient (C_E) on computations of latent heat flux (Q_E) for December. Plotted values are the percentage increase (decrease) in latent heat flux above (below) that computed with a constant exchange coefficient. The contour interval is 10.0.

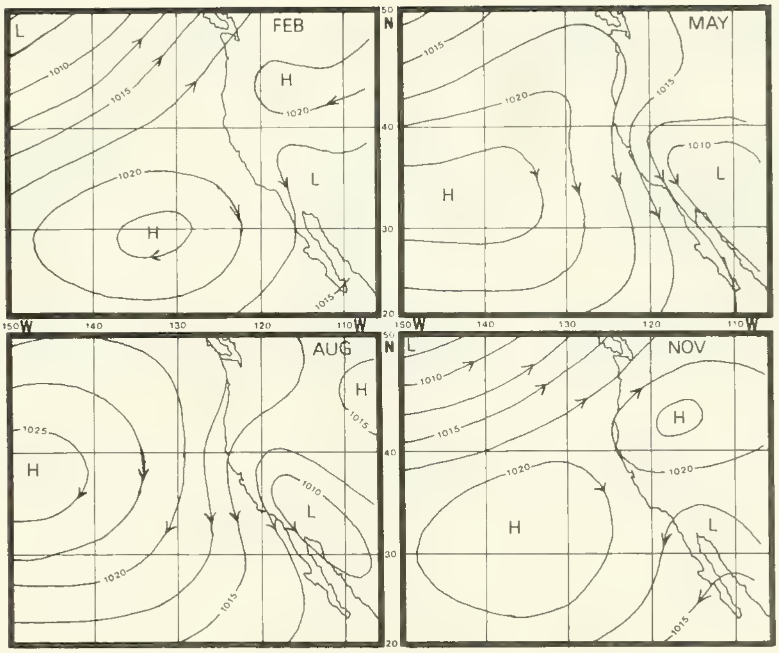

Figure 10.—Mean monthly atmospheric sea level pressure (mbar) over the eastern North Pacific and the west coast of North America during February, May, August, and November. The contour interval is 2.5 mbar (after Reid et al. 1958).

North America during 4 mo of the year (adapted from Reid et al. 1958). During spring and summer (May and August) the subtropical high reaches its maximum northward position and maximum pressure, and at the same time a thermal low pressure system develops over California and Arizona. The large high pressure area shunts migratory cyclones, which pass across the coasts of Washington and Oregon in the fall and winter, well to the north. For winds in geostrophic balance, the surface wind blows parallel to isobars as indicated by the arrow barbs on the isobars. Frictional effects in the planetary boundary layer deflect the surface winds toward low pressure. The composite monthly mean windspeed distributions for June and December, respectively (Figs. 11, 12) illustrate the character of seasonal changes in the surface wind field. During summer (Fig. 11), the region north of lat. 40°N shows relatively low windspeeds of 6 to 7 m/s over almost the entire area. Maximum windspeeds in excess of 9 m/s are found off Cape Mendocino. This offshore maximum is aligned parallel to the coast and maxima can be traced to the south as far as Punta Eugenia, at a distance of about 200 to 300 km from the coast. In contrast, during winter strong onshore winds north of lat. 40°N (Nelson 1977) blow at speeds of 9 to 11 m/s, while the area to the south experiences speeds of 5 to 8 m/s, with a somewhat disorganized pattern (Fig. 12).

During the summer, relatively strong alongshore equatorward winds induce an offshore transport of surface water due to the rotation of the earth acting upon the oceanic response to equatorward wind stress. Conservation of mass requires replacement by convergence in the equatorward surface flow or compensation from below, giving rise to an upwelling of water from intermediate depths along the coast. This upwelling forms a large area of relatively cold water along the coasts of Oregon and California. Figures 13 and 14 show the long-term composite sea surface temperature fields for the months of June and December, respectively, which have been computed from historical surface marine data. The California Current brings relatively cold, freshwater along the west coast of the United States as a branch of the North Pacific Current, which is deflected to the south by the North American continent. In December (Fig. 14) the coldest water is found at the northernmost latitudes, but as the current is deflected to the south the isotherms bend to the south and colder water is found along the coast relative to the water farther offshore. As the water continues south it is warmed by mixing with warmer water offshore and an increase in solar radiation. In June (Fig. 13) cold water is evident at the northerly latitudes, but a large area of cold water (11°-13°C) exists along the coasts of Oregon and northern California. Another region of relatively cool water is found near the coast of Baja California, north of Punta Eugenia. Such conditions persist off Oregon and northern California through September. During the summer, the only possible source for this cold water is from below, because warmer sea surface temperatures occur to the north.

Nelson (1977) described the seasonal variation of the alongshore component of wind stress and discussed the northward progression of the maximum alongshore wind stress from April and May off the coast of Baja California to July and August off Cape Mendocino and Cape Blanco. The movement of this alongshore wind stress maximum, which is an indicator of conditions favorable for upwelling, is the result of the northward shift and strengthening of the subtropical high pressure center and the coincident development of the continental thermal low. An important characteristic of this dome of high pressure is that the atmospheric circulation around the eastern edge of the system is divergent and large-scale subsidence occurs. The combination of the large-scale subsidence of warm air from aloft and the upwelling of cold water along the coast results in the formation of a strong low-level inversion in the marine atmospheric boundary layer. This inversion suppresses deep cloud formation and greatly inhibits precipitation. The effect of the large-scale subsidence is noted in the true desert climate of Baja California, particularly south of Punta Eugenia, and in the almost complete lack of rainfall along the coasts of California and Oregon during summer. Within 10 to 20 km of the coast, upwelling influences the

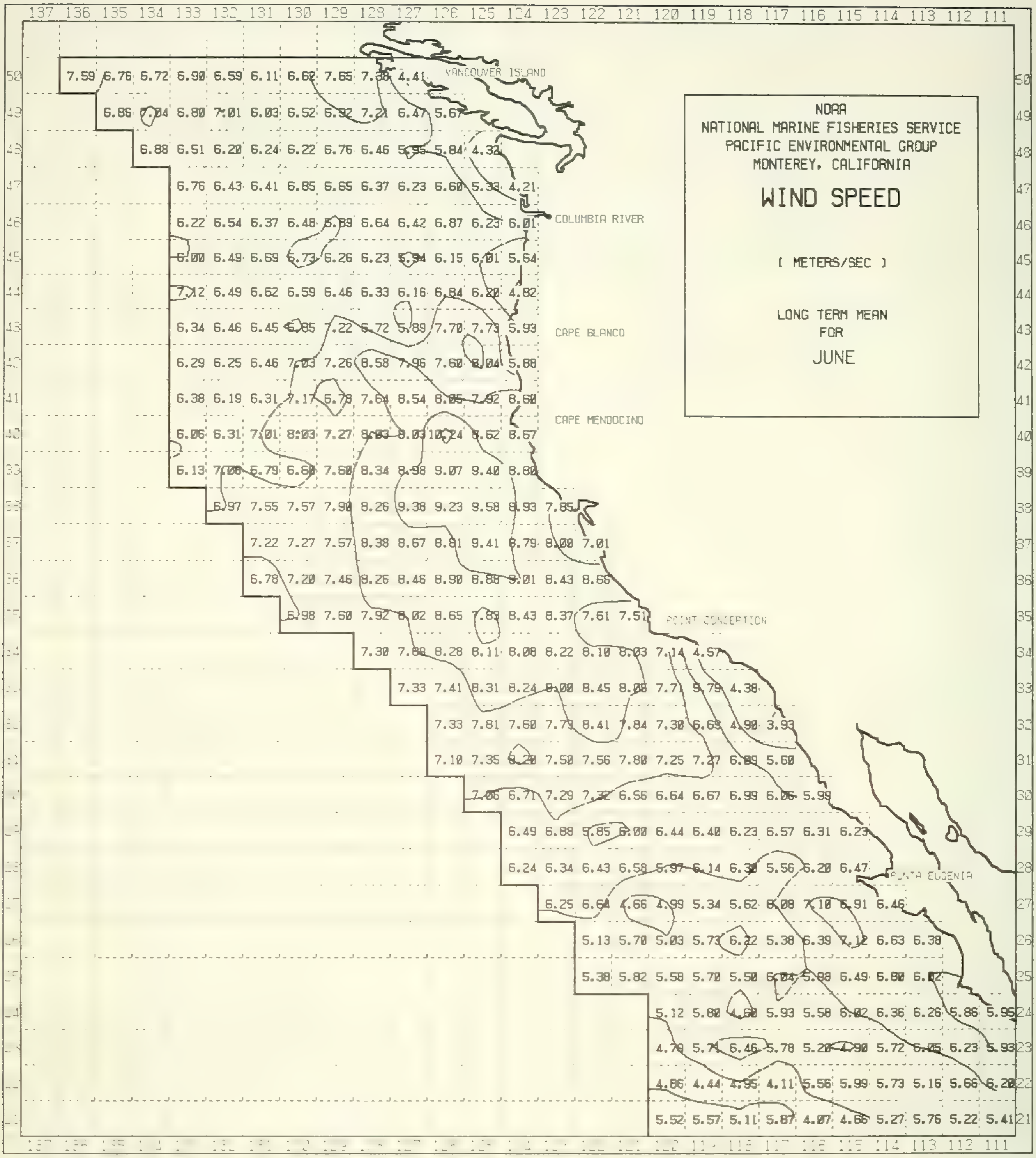

Figure 11.—Long-term composite monthly mean windspeed (m/s) distribution for June. The contour interval is 1.0 m/s.

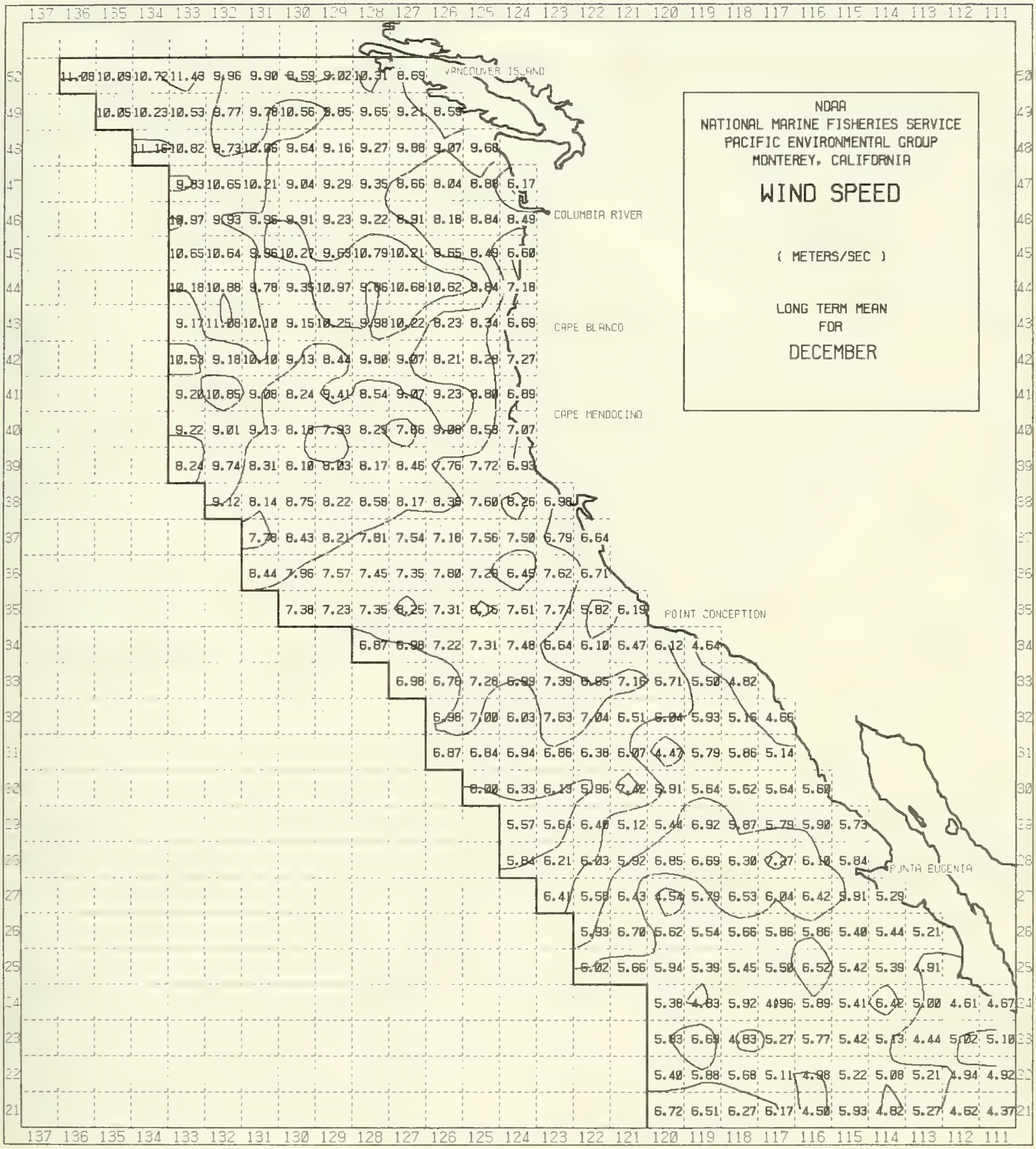

Figure 12.—Long-term composite monthly mean windspeed (m/s) distribution for December. The contour interval is 1.0 m/s.

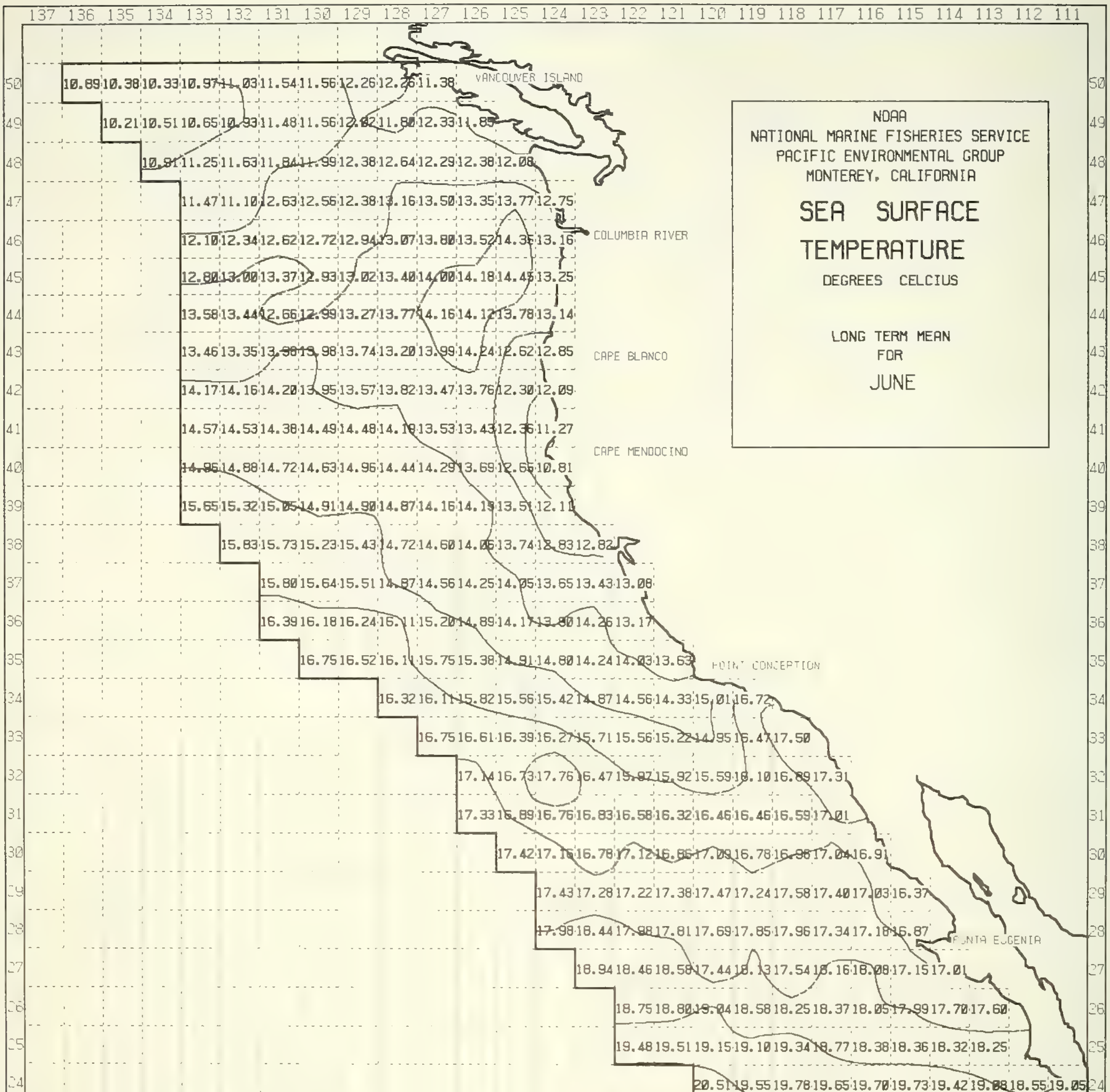

Figure 13.—Long-term composite monthly mean sea surface temperature (°C) distribution for June. The contour interval is 1.0°C.

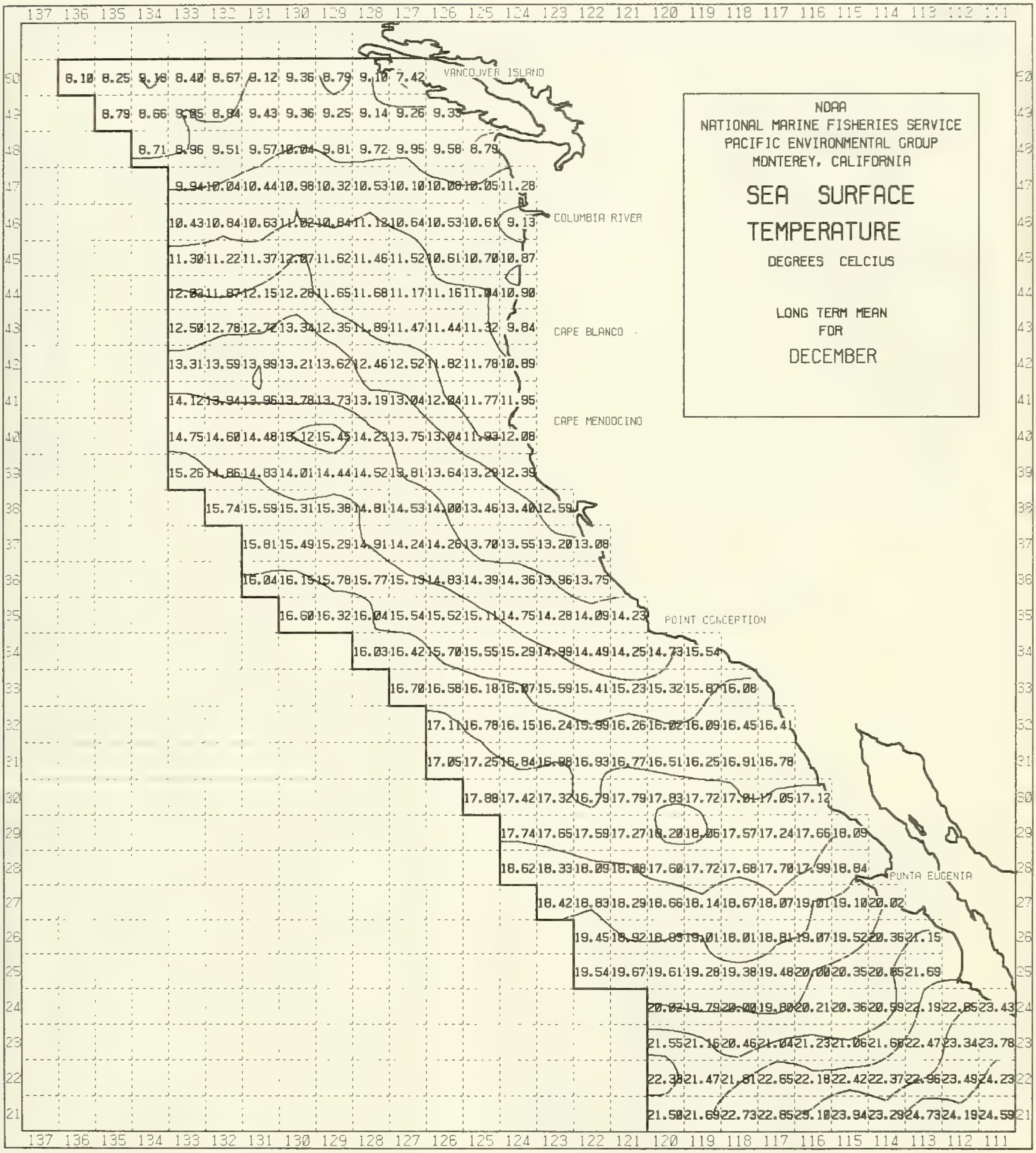

Figure 14.—Long-term composite monthly mean sea surface temperature (°C) distribution for December. The contour interval is 1.0°C.

local climate by contributing to the formation of low stratus clouds and fog below the boundary layer inversion, which lies between 300 and 500 m above the surface. Farther seaward the cloud deck breaks up into cumulus clouds (Neiburger 1960).

DISTRIBUTION OF COASTAL STRATUS IN RELATION TO COASTAL UPWELLING

From May to September the coasts of California and Baja California are influenced by an extensive deck of low-level stratus and stratocumulus clouds. These clouds have a profound effect on the short-wave and net long-wave radiation reaching the sea surface. Figure 15 displays a schematic pattern of this stratus region which was derived from analysis of early satellite photographs by Gerst (1969). Typical surface isobar and sea surface temperature patterns are included in the figure. The wedge-shaped area of stratus clouds has its northern terminus near lat. 40°N; Gerst found that it was most frequently located between lat. 35°N and 41°N. The boundaries of this stratus cloud deck appear to be controlled by the direction of the air flow, the sea surface temperature gradients, and the divergence of the wind field. The coastal boundary of the stratus deck is known to undergo diurnal shifts in the onshore-offshore direction due to the land-sea thermal contrast, which results in the afternoon dissipation of clouds in a narrow zone adjacent to the coast.[5] The diurnal variation of the stratus cloud cover along the coast appears to be strongest in the Southern California Bight south of lat. 34.5°N.

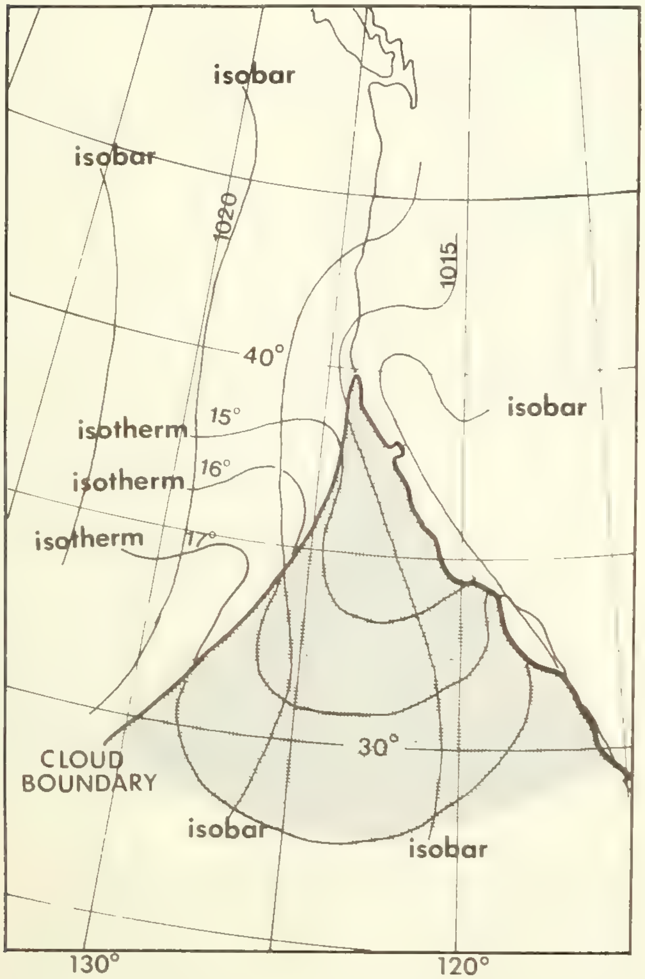

Figure 15.—Schematic diagram of the typical summer pattern of low stratus clouds and the corresponding surface pressure and sea surface temperature patterns (after Gerst 1969). The region of the stratiform cloud mass is shaded. Typical summer values of sea surface temperature (°C) and surface pressure (mbar) are indicated on the chart. The contour intervals are 1.0°C for temperature and 2.5 mbar for pressure.

Neiburger et al. (1945) distinguished between stratus formation processes in southern California and those in central and northern California. Abrupt turning of the coastline at Point Conception, the presence of the Channel Islands, and the extensive area of shallow water influencing the sea temperatures along the coast all contribute to the different nature of the stratus south of lat. 34.5°N. In northern and central California, the formation and dissipation of the stratus was thought to be an advective phenomenon. Frequently the subtropical high pressure center extends into the Pacific Northwest and the winds along the coasts of Oregon and northern California become northeasterly (Lane 1965). This is the situation depicted by the surface isobar pattern in Figure 15. The resulting offshore flow of dry, warm air is not favorable for stratus formation.

The presence of cool, upwelled water in a narrow zone, of the order of 50 km, adjacent to the coasts of Oregon and California, particularly in the vicinity of prominent capes and headlands, is thought to enhance the low level cloudiness and often promotes the formation of fog when the prevailing air flow brings relatively warm, moist air over the cold water. Tont (1975) described a relationship between low values of percent possible sunshine measured at San Diego airport (lat. 32° 44′N, long. 117°10′W) and high values of an upwelling index (Bakun 1973) computed for a location 2° of longitude offshore. He attributed the low values of percentage sunshine during May and June to relatively heavy cloud cover along the coast. Relatively high surface salinity values measured at the Scripps Institution pier during these months were assumed to indicate strong upwelling.

To investigate the relationship between coastal upwelling and low level cloudiness we compared the annual cycles of monthly anomalies of low level cloud amount at several locations known to be influenced by coastal upwelling with the anomalies in 1° squares situated 10° of longitude offshore (Fig. 16). In this figure the deviations of the mean monthly low cloud amounts from the annual mean are plotted for the 1° coastal squares at lat. 40°N, 37°N, 33°N, 30°N, and 27°N and for the offshore squares at the same latitudes. The offshore squares all show positive anomalies during some or all of the months from May to September, with seasonal changes of up to 0.2. At the coastal squares between lat. 30°N and 37°N, the summer increase in low cloud amount is the greatest and the amplitude of the seasonal change is as large as 0.3. The larger amplitude of the seasonal change in low cloud cover between Punta Baja, lat. 30°N, and near Monterey Bay, lat. 37°N, may be attributed to the effects of coastal upwelling. However, the region near Cape Mendocino, lat. 40°N, does not show any significant changes in low cloud amount during summer, although this area experiences the coldest sea surface temperatures during this season (Fig. 13). This lack of an increase in the mean stratus cloud cover may be due to the frequent offshore flow of air (Lane 1965). The monthly statistics of low cloud cover at lat. 40°N showed that approximately 40% of the reports during May through September were coded as clear (i.e., no clouds visible). A large number of clear-sky reports could result from a predominance of reports taken in the afternoon if there were strong diurnal variation in the cloud cover. However, the long-term composite low cloud amounts for the 1° square at lat. 40°N did not show statistically significant differences between the morning (1000 PST) and afternoon (1600 PST) synoptic observation times. The

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[5] Lee, T. F. 1979. Diurnal variations of coastal stratus. Pacific Missile Test Center, TP-80-02, Point Mugu, Calif., 51 p.

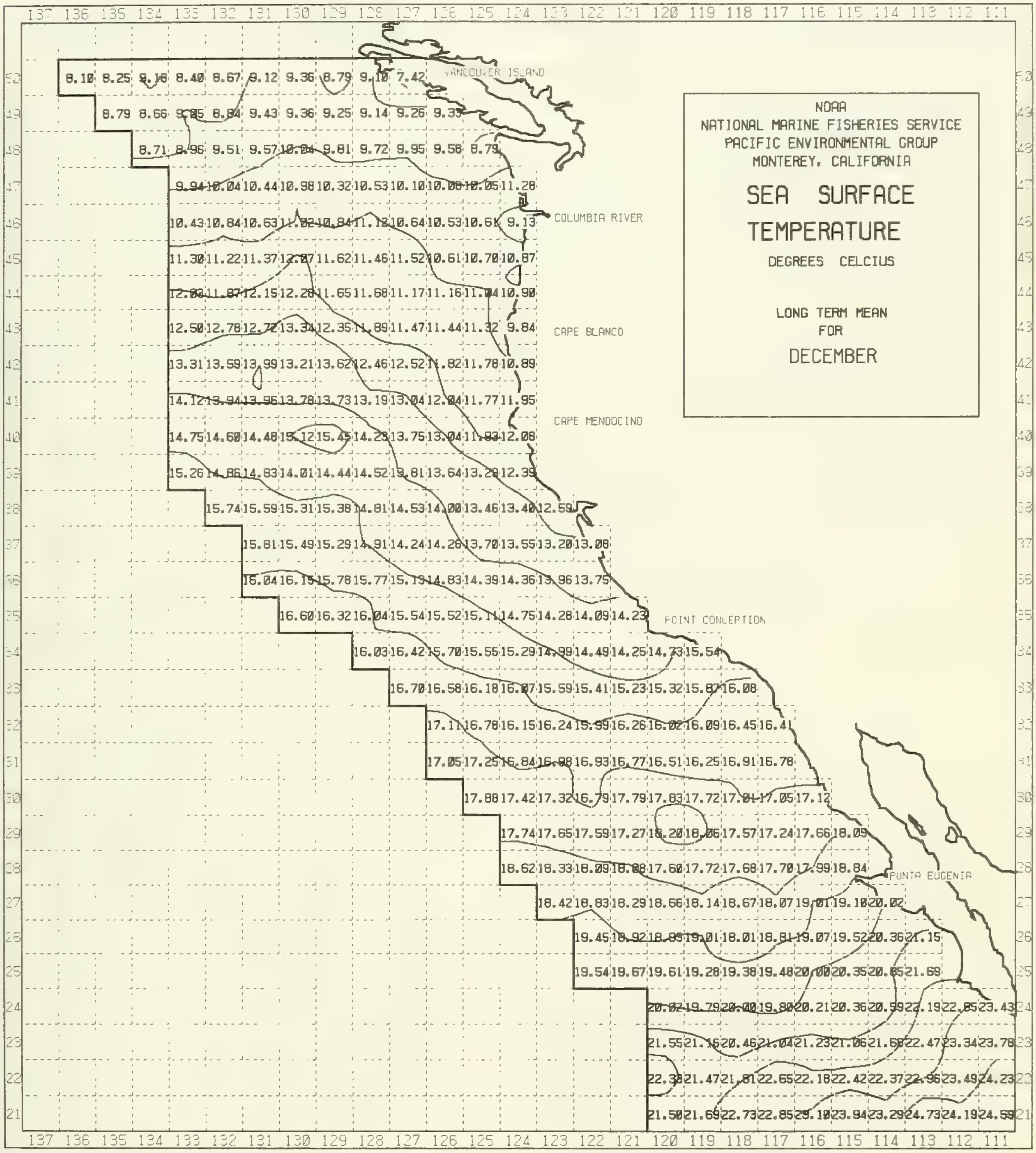

Figure 14.—Long-term composite monthly mean sea surface temperature (°C) distribution for December. The contour interval is 1.0°C.

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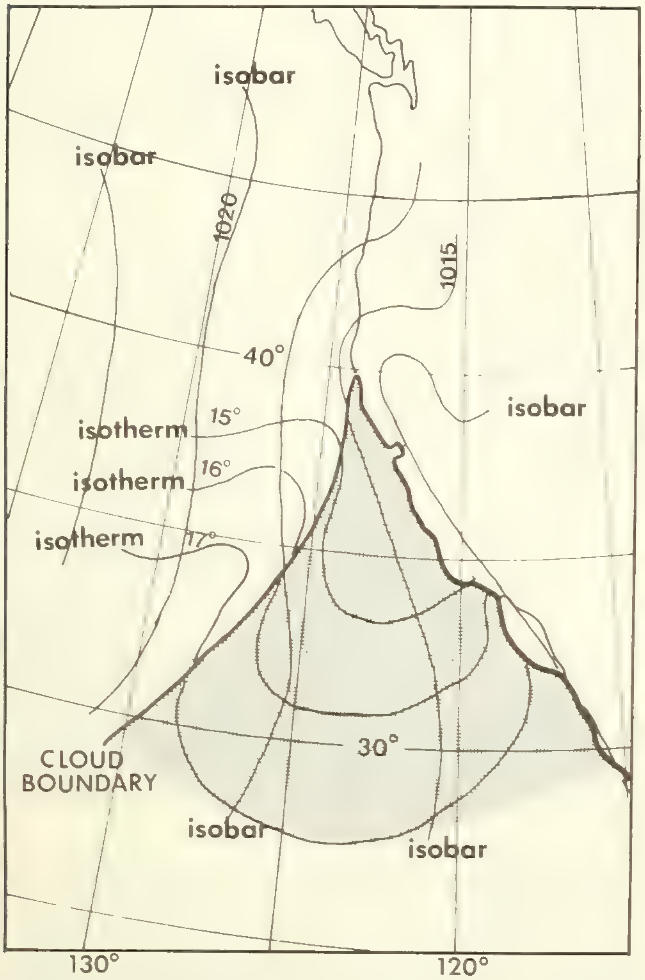

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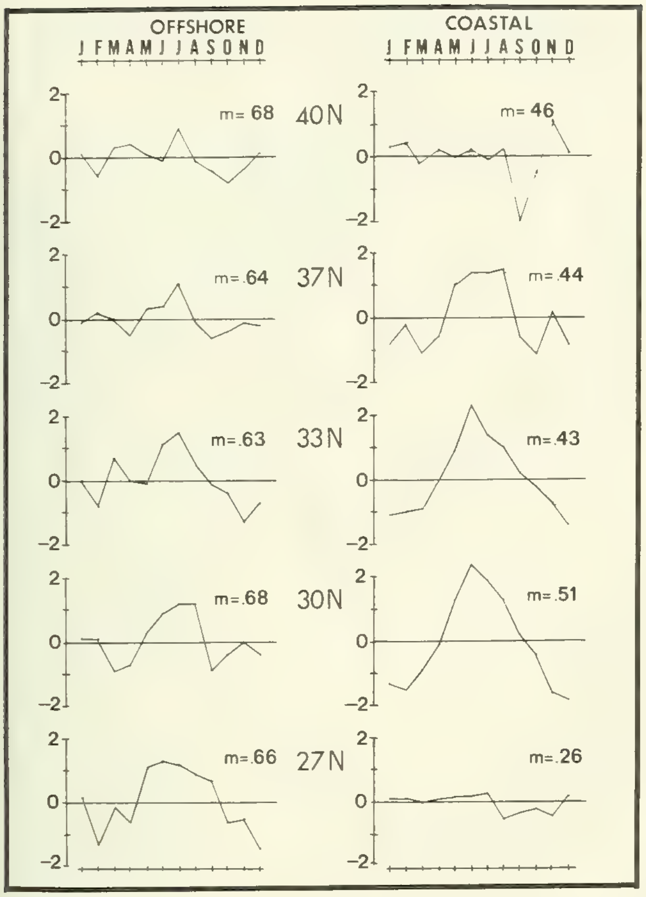

Figure 16.—Monthly anomalies of low cloud amount (tenths) for lat. 40°N, 37°N, 33°N, 30°N, and 27°N in the 1° squares near the coast and 10° offshore. The mean annual low cloud amount from which the anomalies were computed is indicated in each plot by the value (m).

coastal cloud cover near Punta Eugenia at lat. 27°N shows very little seasonal change, reflecting the coastal desert climate of southern Baja California, with cloud cover <0.3 throughout the year.

Although the annual cycles of low cloud cover show local maxima at locations corresponding to the sites of upwelling along the central and southern California coasts, the long-term composite monthly total cloud cover distributions reveal spatial minima in cloud cover at the coast, coincident with areas of cold upwelled water. Figure 17 displays the composite monthly mean total cloud cover for July. Cloud cover values of about 0.5 of sky obscured are found in the Cape Blanco-Cape Mendocino area and south of Point Conception. Beyond 200 to 300 km from the coast, cloud cover varies from 0.7 to 0.8 of sky covered. The low cloud cover south of Punta Eugenia, <0.4, is a permanent feature associated with the persistent offshore flow of dry continental air. The pattern of cloud minima at the coast during summer is substantiated in a number of recent climatological atlases, e.g., U.S. Naval Weather Service Detachment (1977) and U.S. Department of Commerce and U.S. Air Force (1971). Figure 18 displays the composite mean cloud cover over the North Pacific on a 2.5° latitude-longitude grid for July derived from a compilation of satellite images during the period 1965 to 1972.[6] Isopleths are labeled in units equivalent to oktas of sky covered. Values of 3 to 3.5 oktas along the coasts of Oregon and California and off the coast of Baja California are equal to cloud cover of 0.4 to 0.45 of sky covered. These estimates are independent of the surface marine data.

Simon (1977) analyzed mean cloudiness in an area off California from May to September 1975 using 6-hourly photographs from the geostationary satellite SMS-2. He found a minimum cloudiness zone off the coasts of northern and central California, which was closely associated with a region of maximum divergence in the surface winds, particularly during July. The seasonal variation of the minimum cloudiness line appeared to follow the variations of the summer "monsoon" circulation along the California coast. The minimum mean cloudiness values near 0.5 may reflect the tendency for cloudiness in the 1° squares to be either clear or completely overcast, as noted by Simon in his analysis.

A relative minimum in cloud cover and cool sea surface temperatures at the coast during summer increase the short-wave radiation and decrease the net long-wave radiation reaching the sea surface, cause sensible heat flux to the ocean, and reduce the loss of heat from evaporation. In July, cloud cover increases from 0.5 of sky covered near the coast, between lat. 39°N and 44°N, to 0.8 of sky covered offshore (Fig. 17). This change in cloud cover results in a 25% decrease in short-wave radiation, from approximately 275 W/m^2 near the coast to 205 W/m^2 offshore (Appendix I, Chart 7). In this same region, vapor pressure and sea surface temperature increase in the offshore direction as well. The observed zonal gradients in cloud cover, vapor pressure, and sea surface temperature lead to a 55% reduction in computed back radiation, from 40 W/m^2 between Cape Mendocino and Cape Blanco to 18 W/m^2, 10° of longitude offshore (Chart 19). The net effect of the onshore-offshore gradients in cloud cover is to produce a relatively large net radiative flux to the ocean near the coast in comparison with the areas farther offshore.

SEASONAL VARIATION OF THE OCEAN-ATMOSPHERE HEAT EXCHANGE PROCESSES

The mean annual cycles of the various components of surface heat flux presented in Appendix I are shown in Figure 19 for the eight 1° squares indicated in Figure 1. Four of the locations along the coast were chosen to illustrate the effects of coastal upwelling on the heat fluxes and to show the range of conditions from near Vancouver Island (lat. 50°N, long. 127°W) to Punta Eugenia (lat. 27°N, long. 114°W). The other four locations are 10° of longitude offshore from the coastal squares, and were selected to show the contrast of open ocean conditions.

Radiation from sun and sky is a function of the seasonal variation in the declination and altitude of the sun and the cloud cover at a particular location. In the range from lat. 20°N to 50°N, the incoming radiation from a cloudless sky reaches maximum values at all latitudes in mid-June and minimum values in December. The effects of the larger mean total cloud cover in the offshore squares during nearly all months is evident in the smaller $\bar{Q}_S$ values (curve 1) at the offshore locations, except at lat. 50°N where the coastal square experiences greater cloud cover during winter. During summer (Appendix I, Charts 6-8) the gradient in cloud cover from about 0.8 of sky obscured in the offshore region to about 0.5 at the coast amounts to a 15 to 20% increase in incident solar radiation at the coast. The onshore-offshore difference is even greater at lat. 27°N where the coastal desert climate results in a persistent low mean cloud cover of <0.4. The effects of an alongshore gradient in cloud cover near Punta Eugenia are particularly evident in June and July (Fig. 17; Charts 6, 7). A 30% increase in incident solar radiation is realized, and $\bar{Q}_S$ varies from 220 W/m^2 north of lat. 29°N to 290 W/m^2 just south of Punta Eugenia. A relatively constant cloud cover throughout the year is evident in the smooth sinusoidal varia-

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[6] Sadler, J. C., L. Oda, and B. J. Kilonsky. 1976. Pacific ocean cloudiness from satellite observations. UHMET 76-01, Dep. Meteorol., Univ. Hawaii, 137 p.

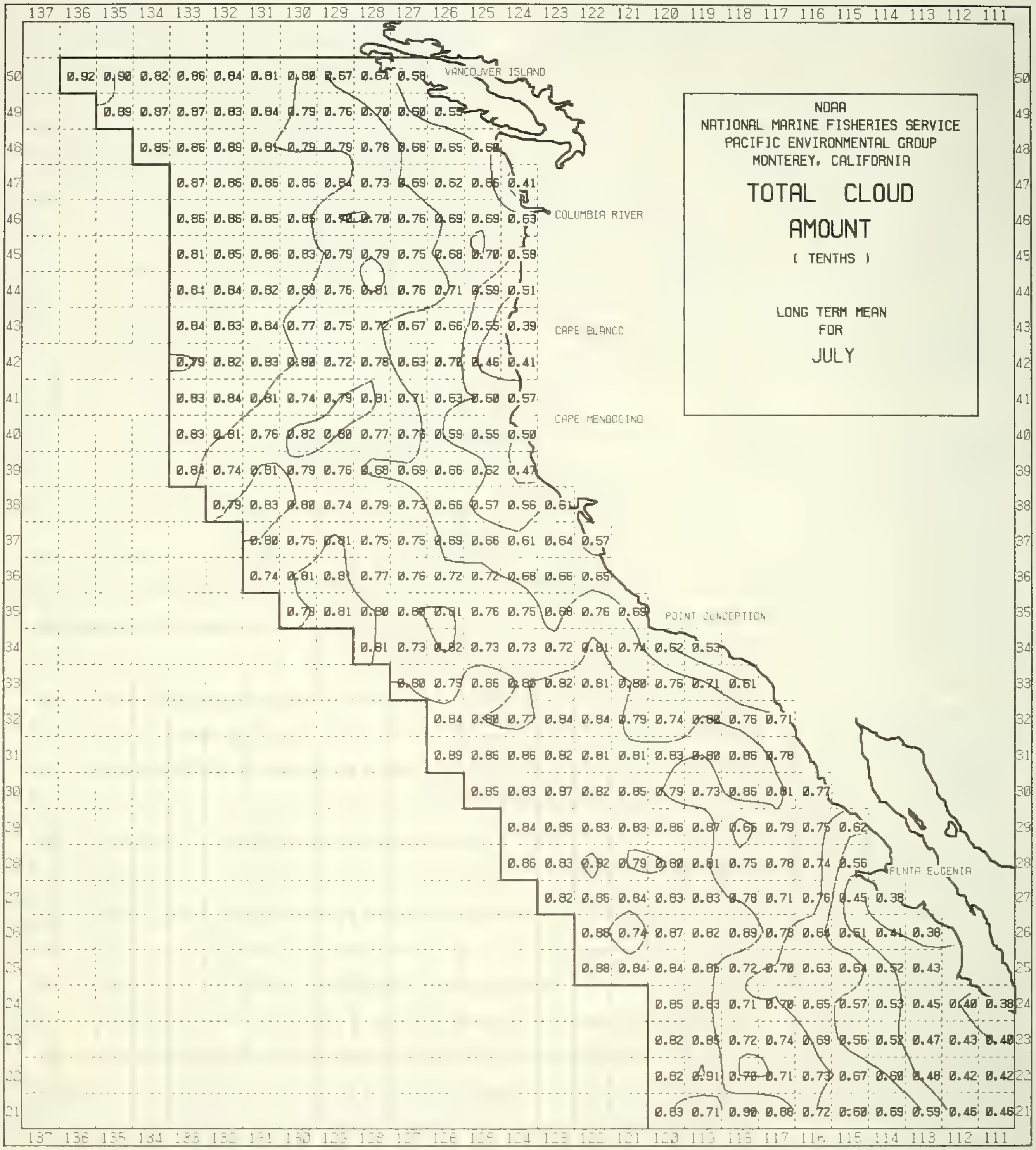

Figure 17.—Long-term composite monthly total cloud amount (tenths) distribution for July. The contour interval is 0.1.

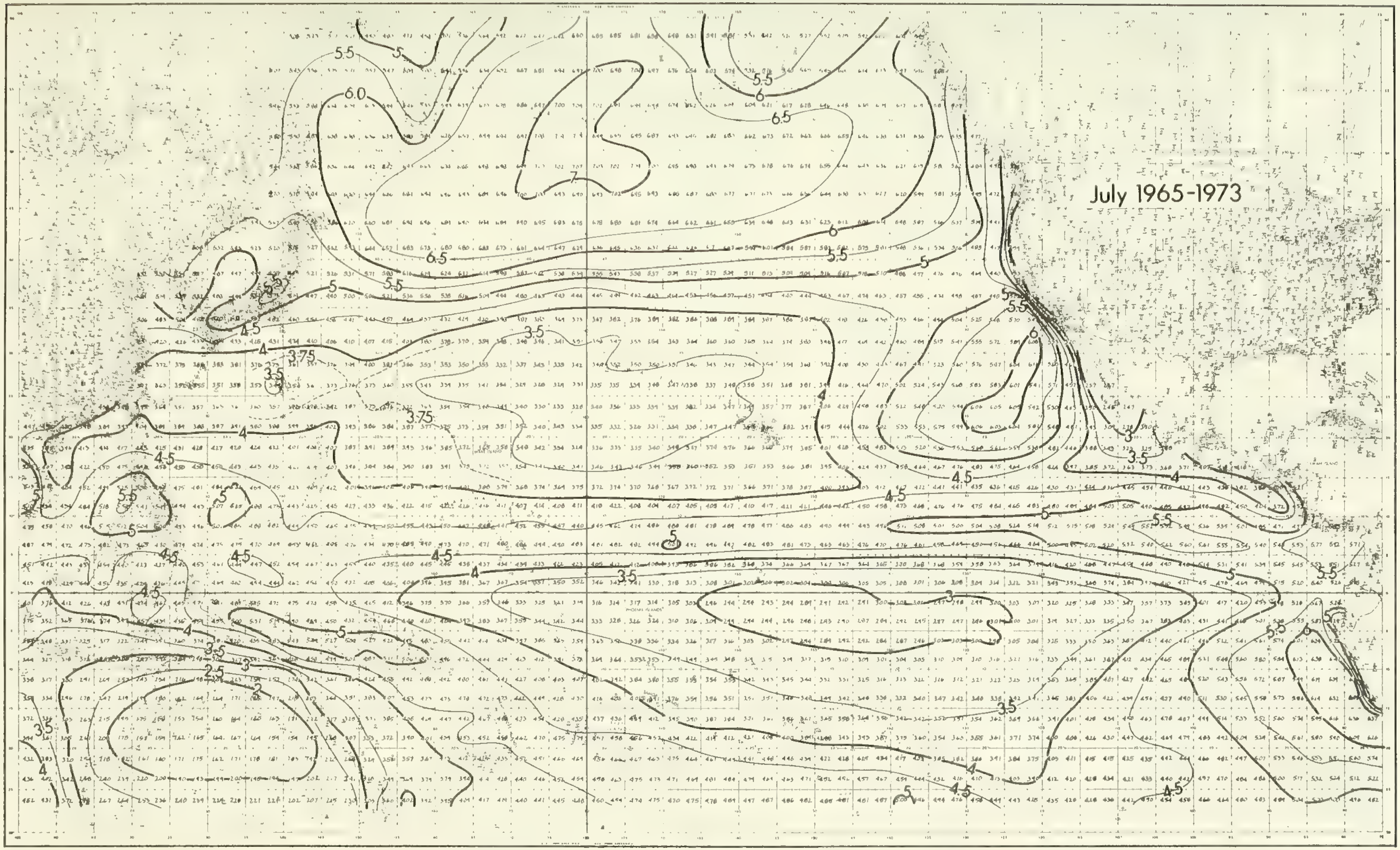

Figure 18.—Composite monthly mean total cloud cover (oktas) over the North Pacific Ocean for July derived from nephanalyses of meteorological satellite photographs during the period 1965-73. The 2.5° latitude-longitude grid extends from 30°S to 60°N latitude and from 105°E to 75°W longitude. The contour inteval is 0.5 okta (after Sadler et al. 1976).

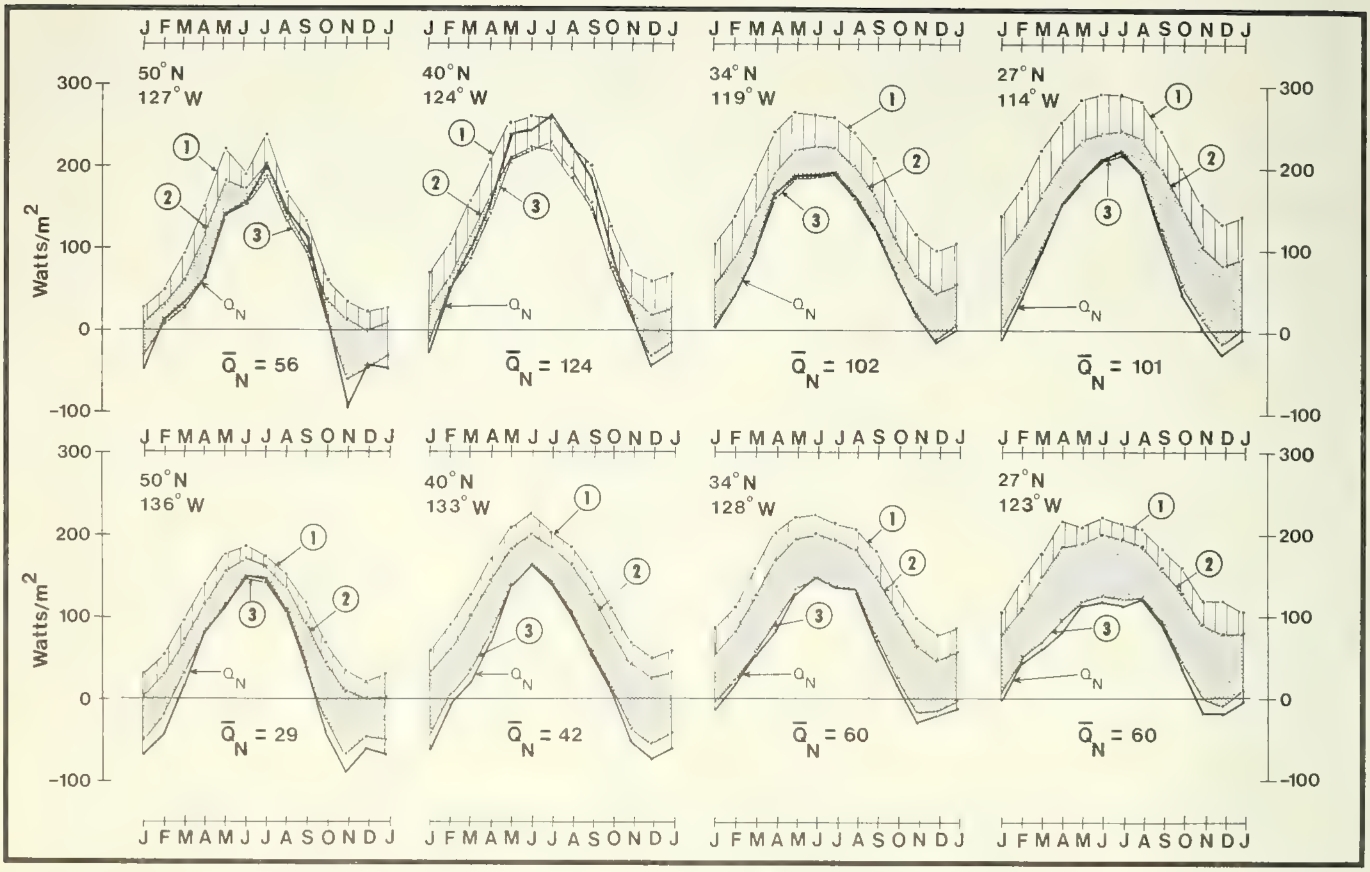

Figure 19.—Mean annual cycles of heat exchange processes for the 1° squares at lat. 50°N, 40°N, 34°N, and 27°N near the coast and 10° offshore. The upper row displays 1° square values at the coast and the lower row displays the offshore exchange processes. 1 denotes values of $\bar{Q}_S$; 2 denotes $\bar{Q}_S - \bar{Q}_B$; 3 denotes $\bar{Q}_S - \bar{Q}_B - \bar{Q}_E$, and the heavy line denotes $\bar{Q}_N = \bar{Q}_S - \bar{Q}_B - \bar{Q}_E - \bar{Q}_C$. The hatched regions between 1 and 2 denote the magnitude of $\bar{Q}_B$ and the stippled regions between 2 and 3 indicate the magnitude of $\bar{Q}_E$. The annual mean net heat exchange ($\bar{Q}_N$) is indicated for each location. Units are W/m².

tion of solar radiation at the coastal square at lat. 27°N with the minimum value of 131 W/m² in December and the maximum value of 290 W/m² in June.

The annual range of monthly $\bar{Q}_S$ values is larger in the coastal upwelling areas off northern California and Oregon than in the corresponding squares offshore, which primarily reflects the effect of relatively low cloud cover in summer when the input of solar radiation is the highest. The range is largest near the coast at lat. 40°N and 50°N where values range from <50 W/m² in winter (Chart 12) to more than 200 W/m² in summer (Chart 6). The lack of well-defined maximum in solar radiation in the offshore squares at lat. 27°N and 34°N is indicative of the extensive area of low-level stratocumulus clouds previously discussed.

The hatched areas between the two topmost curves for each location in Figure 19 indicate the annual cycles of heat loss due to effective back radiation, $\bar{Q}_B$. This term shows little seasonal or latitudinal variation over the entire California Current region. However, there is a tendency for lower values in summer (Chart 18) than in winter (Chart 24), except near the coast between San Francisco (lat. 38°N) and Vancouver Island (lat. 50°N). The principal gradients in the distributions of $\bar{Q}_B$ are zonal and reflect the sharp increase in mean cloudiness from the coast toward midocean. The higher mean cloud cover offshore reduces the magnitude of the net long-wave flux emitted from the sea surface to approximately 20 W/m². Near the coast the estimated heat loss exceeds 50 W/m². The effects of horizontal variations in cloud cover on $\bar{Q}_B$ are enhanced, but to a lesser extent, by corresponding increases in atmospheric vapor pressure in the offshore direction, and moderated by warmer sea surface temperatures offshore with respect to conditions near the coast.

The annual cycles of latent heat flux from ocean to atmosphere are shown in Figure 19 by the stippled regions between curves 2 and 3. Variations in the latent heat flux are related to fluctuations in windspeed and sea-air vapor pressure differences. The principal seasonal variations in $\bar{Q}_E$ occur in the nearshore areas particularly between Cape Mendocino and the Columbia River. In this region, the presence of cold upwelled water at the sea surface in summer cools the air, lowers the vapor pressure of the air close to the saturation vapor pressure at the sea surface temperature, and effectively suppresses latent heat flux. This effect is noted by minimum values of latent heat flux in a narrow coastal zone from Cape Mendocino to Vancouver Island during June, July, August, and September (Charts 30-33). In this region the latent heat flux is lowered to values of <5 to 20 W/m². In certain locations the turbulent flux may actually be from atmosphere to ocean (i.e., condensation). The nearshore areas south of lat. 40°N are characterized by relatively constant values of $\bar{Q}_E$, about 50 to 70 W/m², except in the upwelling regions south of Punta Baja (lat. 30°N) and south of Punta Eugenia (lat. 27°N) in spring and summer. Latent heat flux decreases to values of 30 to 40 W/m² at these locations due to the depression of the sea-air vapor pressure difference.

Seasonal variations in $\bar{Q}_E$ are less pronounced in the offshore regions. Higher mean windspeeds and larger sea-air vapor pressure differences contribute to evaporative fluxes which are 30 to 100% greater in winter (Chart 36) than in summer (Chart 30). Horizontal gradients of $\bar{Q}_E$ lie in a southwest-northeast direction and values of latent heat flux are approximately 20 to 40 W/m^2 larger in southern and offshore sections of the grid than in the northern and inshore regions. Values range from about 30 to 60 W/m^2 north of lat. 40°N to about 60 to 100 W/m^2 south of lat. 30°N. The observed spatial distributions of $\bar{Q}_E$ primarily result from systematic variations in sea-air vapor pressure differences and to a lesser extent from horizontal gradients in windspeed. Monthly mean winds are, at most, only twice as large off the Pacific Northwest compared with values off Baja California. However, mean sea-air vapor pressure differences are 2 to 4 times greater in the southern region than in the northern section and 2 to 3 times larger offshore than near the coast. The north-south contrast is particularly evident in winter (Charts 25–27) when the atmospheric circulation off the coast of southern Baja California contributes to relatively large mean sea-air vapor pressure differences ($\bar{e}_w - \bar{e}_a > 10$ mbars). During summer (Charts 30-32), east-west gradients in $\bar{Q}_E$ are enhanced by the reduction in latent heat flux near the coast due to the local effects of upwelling.

Sensible heat flux between ocean and atmosphere is depicted in Figure 19 by the difference between curve 3 and the heavy line denoting $\bar{Q}_N$. The magnitude of $\bar{Q}_C$ is virtually negligible over much of the California Current region due to the small sea-air temperature differences ($\bar{T}_s - \bar{T}_a < 1.0$°C) over the area during most of year. The sensible heat flux from ocean to atmosphere ranges from near 0 to 20 W/m^2 over most of the grid with the higher heat losses ($\bar{Q}_C > 30$ W/m^2) during winter in the northern latitudes (Charts 37, 38, 47, 48).

The largest $\bar{Q}_C$ values occur during summer in the area adjacent to Cape Mendocino and Cape Blanco, when upwelling of cold water causes mean air-sea temperature differences to exceed 1.5°C; the ocean receives a sensible heat gain of up to 30 W/m^2 (Charts 42-45). Sensible heat gains are <5 W/m^2 during late spring and summer along the coast of Baja California and values of 5 to 10 W/m^2 extend over broad regions from Point Conception to Vancouver Island during May, June, July, and August. In a region off the coast of Washington, high vertical stability associated with the Columbia River freshwater plume (Barnes et al. 1972) may contribute to relatively warm sea surface temperatures and, consequently, to sensible heat loss in this area (Charts 41-43).

The net heat gain or loss across the sea surface, $\bar{Q}_N$, is indicated by the heavy lines in Figure 19. The annual mean net heat exchange is characterized by heat transfer to the ocean over the entire region, a feature previously described by Wyrtki (1965). The annual net heat gain is much larger near the coast than offshore as a result of small heat losses by turbulent heat fluxes and the greater input of solar radiation due to the lower relative cloud cover during summer. The ocean loses heat to the atmosphere over the entire area only in December (Chart 60).

Over most of the California Current region the net heat exchange is determined by a balance between the incident solar radiation and the heat losses due to effective back radiation and latent heat flux. In the offshore regions the largest heat loss term is the latent heat flux, $\bar{Q}_E$, while along the coast the effective back radiation, $\bar{Q}_B$, is the largest heat loss term. Seasonal variations in the components contributing to oceanic heat loss are largest in the coastal upwelling regions off northern California and Oregon and to a lesser extent off the coasts of Baja California and Vancouver Island where the presence of cold upwelled water in late spring and summer reduces the turbulent flux of latent heat and causes sensible heat gain to the ocean, thereby increasing the heat input to the ocean.

The coastal upwelling zones along the west coast of the United States and Baja California experience the largest net annual heat gain as a result of the combined effects of the increase in incident solar radiation in regions of minimum cloudiness and the decrease in heat losses by turbulent fluxes. The net annual heat gain is largest off Cape Mendocino with a mean value of 124 W/m^2. Seasonal variations in the net heat exchange within the 1° squares adjacent to the coast are graphically portrayed in the time series isogram displayed in Figure 20. The coastal zone north of lat. 47°N is characterized by net heat losses of more than 100 W/m^2 during December and January and net heat gains of 200 W/m^2 during July. The coastal upwelling zone between lat. 38°N and 44°N shows net heat gains of 200 to 250 W/m^2 during July and relatively small heat losses of 20 to 40 W/m^2 during winter. The coastal square at lat. 34°N, southeast of Point Conception, experiences net heat gain during nearly the entire year with maximum heat gain >180 W/m^2 during May, June, and July.

There are considerable latitudinal differences in the annual cycles of net heat exchange along the coast of Baja California. The region near Punta Baja (lat. 30°N) is characterized by a relatively small maximum net heat gain during summer of about 150 W/m^2 due to high cloud cover (0.8) during June and July. The area south of Punta Eugenia (lat. 27°N) is influenced by a less extensive cloud deck and shows much higher net heat gain, >200 W/m^2, during spring and summer (Charts 53-56), which may mask the effects of coastal upwelling on sea surface temperatures in this area (Bakun and Nelson 1977).

Spectral Characteristics of Heat Exchange Processes

The monthly mean data described in this report resolve the annual cycle. However, marine biological communities must respond to a wider spectrum of atmosphere-ocean variations on time scales ranging from a few days to several years. Relatively rapid diurnal and "event scale" fluctuations (i.e., periods of 1-10 d) contribute to turbulent mixing and dispersion of biological microstructure. Lower frequency "climatic" variations, which appear as long-term trends or periodicities, or as interyear differences, affect fisheries over much broader space and time scales. Year-to-year fluctuations in the timing, amplitude, and spread of the seasonal production cycle in major spawning regions may induce significant changes in recruitment of year classes to the fisheries (Cushing 1975). Annual differences in the character of the production cycle are environmentally controlled and related to changes in the stability of the upper water column which is enhanced by an increase in solar radiation and a decrease in wind strength.

Available ship reports are unevenly distributed in space and time. Therefore, it is generally not possible to construct consistent time series of air-sea interaction processes for large regions and preserve fine spatial resolution, by applying the simple space and time averaging methods which were used to assemble the long-term monthly means. Where the density of reports is large, e.g., within 300 km of the coast south of Point Conception, statistically significant monthly mean values might be computed over fairly long periods. A few time series of air-sea interaction processes have been produced, either by compositing ship reports in 5° square blocks (Clark et al. 1974) or by making use of objectively analyzed meteorological products (Bakun 1973) which have a spatial resolution of approximately 3°. Analyses of these data show wide variations in space and time. However, the errors associated with the low frequency, nonseasonal fluctuations are generally unknown, and there is little coherence or persistence in the monthly anomaly patterns of the heat exchange processes (Clark et al. 1974).

Seasonal and nonseasonal fluctuations in net heat exchange, $\bar{Q}_N$, were investigated at a few selected locations in the Southern Cali-

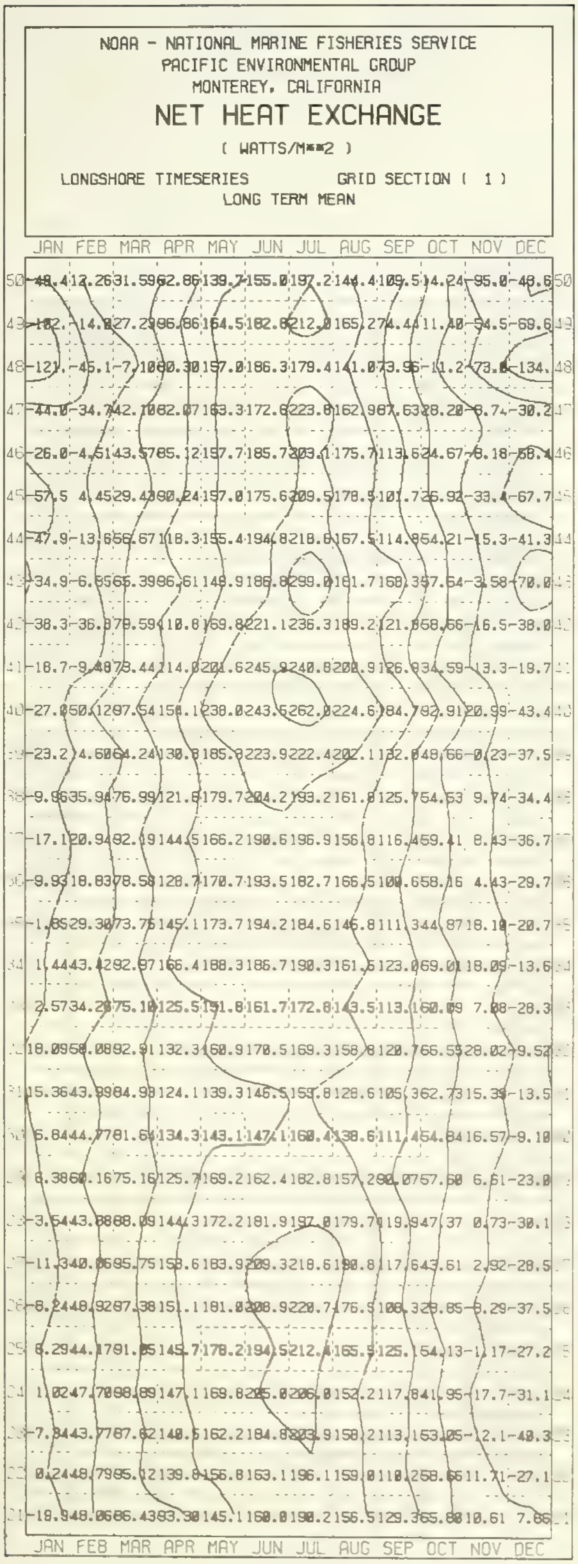

Figure 20.—Seasonal cycle of net heat exchange near the coast. Means of net heat exchange were computed by month for the 1° squares immediately adjacent to the coast. Units are W/m². The contour interval is 50.0 W/m². Negative values are shaded and indicate net heat loss from ocean to atmosphere.

fornia Bight (lat. 32°N, long. 117°W; lat. 32°N, long. 118°W; lat. 32°N, long. 119°W) and near Punta Eugenia (lat. 27°N, long. 114°W; lat. 27°N, long. 115°W). A 23-yr time series (1950-72) of monthly values was computed for each 1° square. For these particular grid points, the computed values were based on an average of 10 to 30 observations/mo. Spectrum analysis was used to demonstrate the predominance of the annual cycle and to possibly identify other frequency bands accounting for substantial variance.

Power spectra of $\bar{Q}_N$ at each location (Fig. 21A, B) show strong peaks at frequencies representing the annual cycle and suggest lesser peaks corresponding to a semiannual component. Referring to the 95% confidence limits for 10 degrees of freedom, it is clear that the variance associated with the annual cycle is at least an order of magnitude larger than the average level of variance at lower or higher frequencies. Within the Southern California Bight (Fig. 21A), no significant long period fluctuations are apparent. Near Punta Eugenia (Fig. 21B), there is a general increase in spectral energy density at low frequencies, from a relative minimum at a frequency corresponding to a 2-yr cycle to a relative maximum for periods exceeding 8 yr. This feature is also evident in power spectra of monthly anomalies of $\bar{Q}_N$ (Fig. 21C), for which the seasonal variation in the time series has been removed by subtracting out the long-term (1950-72) monthly mean values. The increase in variance at low frequencies reflects the general 2- to 6-yr persistence in the sign of the annual $\bar{Q}_N$ anomalies at these locations.

Time series of net heat exchange may be characterized by large interannual differences, persistence, and long-term trends. However, these features may not be spatially coherent. Coherence functions were computed to test the significance of correlations between time series of $\bar{Q}_N$ in adjacent 1° squares. In the Southern California Bight (Fig. 21A), coherency squared consistently exceeds the 95% significance level for 10 degrees of freedom only in the frequency band from 0.06 to 0.11/mo (0.7 to 1.3/yr). The spread over several frequency bands reflects the nonsinusoidal shape of seasonal fluctuations which tend to have a faster rate of change in spring and fall than in summer or winter. Near Punta Eugenia (Fig. 21B), coherency squared is significant (95% level) at frequencies corresponding to semiannual and annual periodicities and at frequencies <0.03/mo (0.4/yr). Low frequency coherence remains significant at the 95% level after seasonal variations have been removed (Fig. 21C). The lack of significant coherence between adjacent squares in the Southern California Bight probably reflects the large uncertainty in net heat exchange calculations based on surface observations archived in the TDF-11 file, but also may be related to significant spatial variations over distances <200 km in this region.

These data demonstrate the relatively large amplitude of the annual cycle in midlatitude atmospheric properties, which suggests that the long-term monthly mean heat exchange fields (Appendix I) represent the expected seasonal variability. More extensive time series calculations have been published by Clark et al. (1974). However, the wide variations and lack of persistence in patterns of net heat exchange anomalies computed from their data, in addition to our own results, support the conclusion that merchant vessel data may not always be sufficiently reliable to compute statistically significant indices of the month-to-month or interannual variations in air-sea interaction processes (Husby 1980).

Heat Budget of a Coastal Upwelling Region

The principal processes affecting the seasonal variation of air-sea heat transfer over the California Current are related to seasonal changes in the atmospheric circulation patterns which modify the cloud cover and the oceanic circulation. Coastal upwelling has a marked effect on the turbulent fluxes of heat, particularly off north-

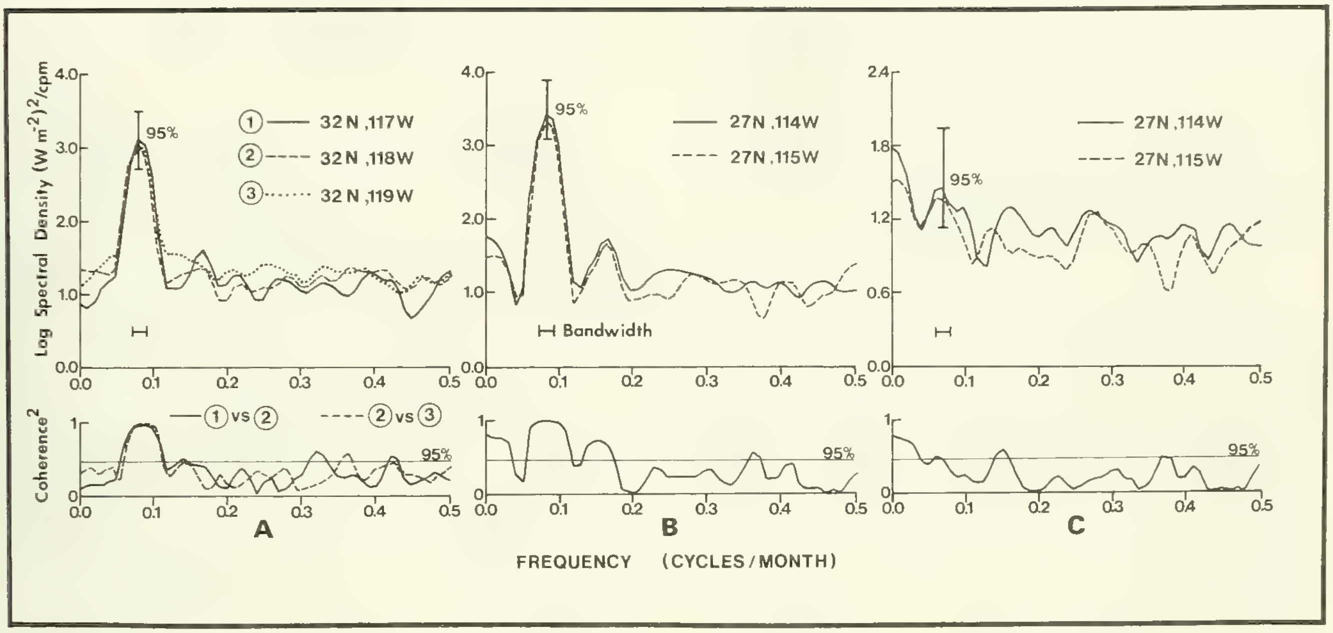

Figure 21.—Power and coherence spectra of monthly mean net heat exchange estimates for 1950-72. Spectra are plotted for time series at A) lat. 32°N, long. 117°W; lat. 32°N, long. 118°W; lat. 32°N, long. 119°W and B) lat. 27°N, long. 114°W; lat. 27°N, long. 115°W. Spectra of the monthly anomalies from the long-term monthly means at lat. 27°N, long. 114°W and lat. 27°N, long. 115°W are displayed in Figure C.

ern California and Oregon. On an annual time scale the entire region experiences net heat gain to the ocean. Previous summaries have shown that the North Pacific Ocean gains heat primarily on the eastern side (Wyrtki 1965), and we have shown that the net heat gain reaches a maximum in the coastal upwelling region off northern California as a consequence of relatively low cloudiness and a change in sign of the turbulent heat fluxes at the sea surface due to the presence of cold water during summer. In the absence of a climatic increase in the mean sea surface temperature along the coast (i.e., in a steady state balance), this net annual heat gain must be balanced by mixing and cold advection, i.e., the influx of cold water into the region, either by horizontal or vertical motions.

In the region of maximum offshore Ekman transport between Cape Mendocino and Cape Blanco, the amplitude of the annual cycle of sea surface temperature is suppressed (Bakun et al. 1974). Near the coast, the difference between minimum and maximum temperatures is <3°C. From May to September, $\bar{T}_s$ increases at a mean rate of 0.5°C/mo. In the offshore areas, the seasonal range of sea surface temperature exceeds 6°C and $\bar{T}_s$ increases at a rate >1.5°C/mo during summer. In the California Current, maximum sea surface temperatures occur in September, well after the period of maximum net oceanic heat gain in June and July. However, the maximum in the annual cycle of $\bar{Q}_N$ corresponds directly to the maximum rate of change in surface temperature.

The equation of conservation of heat for an incompressible fluid, expressed in terms of mean temperature, $\bar{T}$, is given by:

$$\frac{\partial \bar{T}}{\partial \bar{t}} = \frac{\bar{Q}_N}{\rho_0 c_p z} - \overline{\vec{V}}_H \bullet \nabla_H \bar{T} - \bar{w}\frac{\partial \bar{T}}{\partial z} + A_H \nabla_H{}^2 \bar{T} + A_z \frac{\partial^2 \bar{T}}{\partial z^2} \qquad (11)$$

where $\partial/\partial t$ is the local time rate of change with time scales large compared with the averaging time; $\bar{Q}_N$ is the mean net heat exchange across the sea surface which heats a column of water extending from the surface to a depth z; ρ_0 is density; c_p is the specific heat of water at constant pressure; $\vec{V} = \vec{ui} + \vec{vj}$ is the mean horizontal velocity; $\bar{w}$ is the mean vertical velocity component (positive upward); ∇_H and $\nabla^2{}_H$ are the horizontal gradient and Laplacian, respectively; and A_H and A_Z are the horizontal and vertical coefficients of eddy thermal conductivity. Assuming a constant mixed layer depth, the terms in Equation (11) express a balance between the local change of temperature (heat content) and those changes resulting from radiative and turbulent heat fluxes across the air-sea interface and horizontal and vertical advection and diffusion (i.e., mixing).

To test the general validity of our heat exchange calculations we applied Equation (11) to the upper 30 m of the water column in a 3° square adjacent to Cape Mendocino and centered at lat. 40°N, long. 125°W. The terms were evaluated by month and averaged over the "upwelling season" from May to September to obtain a mean seasonal heat budget appropriate for this region. We used climatological surface and subsurface temperature data (Robinson 1976) to estimate the local change, the horizontal and vertical gradients, and the second derivatives of temperature. Mean east and north components of velocity were obtained from seasonal distributions of surface currents based on ship drift observations (Stidd 1974).

During summer, the mean net heat flux, $\bar{Q}_N$, across the air-sea interface is 180 W/m^2. To calculate the equivalent rate of change in temperature, we used the constant values $\rho_0 = 1.0 \times 10^3$ kg/m^3, $c_p = 4.180 \times 10^3$ J/kg per °C, and $z = 30$ m. This mean surface flux equals a temperature increase at the rate of 3.7°C/mo. However, the local change of temperature in the upper 30 m is only 0.6°C/mo. The excess heat input at the surface must be balanced by horizontal and vertical advection and diffusion.

We estimated mean zonal and meridional temperature gradients of -7.4×10^{-3} and -3.6×10^{-3} °C/km, respectively. The corresponding second derivatives were 4.7×10^{-5} °C/km^2 in the east-west direction and 2.0×10^{-5} °C/km^2 in the north-south direction. Combining these values with mean east and north velocity components of -2.0 and -10.0 cm/s and assuming a horizontal eddy diffusion coefficient of 100 m^2/s (Bathen 1971) gives a mean horizontal advection ($-V_H \bullet \nabla_H \bar{T}$) of -1.3°C/mo and mean horizontal diffusion ($A_H \nabla^2{}_H T$) of 0.02 °C/mo. The sign of the advection term implies cold advection which is consistent with a surface temperature gradient from southwest to northeast (Fig. 13) and an equatorward surface current with an offshore component (Pattullo et al. 1969). At a depth of 30 m the vertical second derivative of temperature is -8.0 × 10^{-4} °C/m^2. The approximate scale for the vertical eddy diffusion coefficient is $A_H/A_Z = 1.0 \times 10^{-6}$ (Pond and Pickard 1978); consequently $A_Z = 1.0 \times 10^{-4}$ m^2/s. Therefore, vertical mixing, as parameterized in Equation (11), leads to a loss of heat at the base of the water column at the rate of 0.2°C/mo. From the balance of terms in Equation (11), we inferred mean vertical temperature advection ($-\bar{w}\partial\bar{T}/\partial z$) of -1.6°C/mo. In this region, the mean vertical temperature gradient in the upper 30 m is approximately 0.05°C/m. These values imply a mean (upward) vertical velocity of 32 m/mo, which lies within the range of estimates for coastal upwelling regions (Wooster and Reid 1963). Similar heat budget calculations for an upwelling region off Cabo Bojador (Bowden 1977) yielded substantially larger 10-d mean vertical velocities (e.g., 4-10 m/d). The magnitudes of the terms in Equation (11) imply that the primary balance in coastal upwelling regions is between surface heat flux and horizontal and vertical advection.

The vertical velocity computed from the heat budget equation is considerably larger than the mean open ocean vertical velocity associated with horizontal divergence in the surface Ekman layer (Yoshida and Mao 1957). We used the approximate relationship,

$$w \approx \frac{\vec{k} \bullet (\nabla \bullet \vec{\tau})}{\rho_o f}, \qquad (12)$$

where $\vec{k} \bullet (\nabla \bullet \vec{\tau})$ is the vertical component of wind stress curl, and f is the Coriolis parameter, and distributions of wind stress curl (Nelson 1977) to independently compute a mean upwelling velocity of 5 m/mo. The heat budget calculations would be consistent with this estimate of $\bar{w}$ if the surface heat flux, $\bar{Q}_N$, were distributed from the surface to a depth of 50 m.

The uncertainty in each of the terms in Equation (11) may be as large as the error in $\bar{Q}_N$, which we estimated to be 15 to 70%. Roden (1959) estimated an error of 50% in calculating the horizontal advection term from observed velocity components and temperature gradients. In addition, the physical basis for parameterizing vertical mixing as a function of a constant eddy coefficient, A_Z, and the vertical second derivative of temperature, $\partial^2\bar{T}/\partial z^2$, is not well founded. Therefore, the computed vertical eddy diffusion may grossly underestimate the effects of mixing at the base of the mixed layer (Niiler and Kraus 1977). In our heat budget calculations, an order of magnitude increase in A_Z would have resulted in an approximate balance between heat gain at the surface and heat loss by horizontal advection and vertical mixing, without the requirement for vertical advection. Because of the uncertainties associated with heat budget calculations, the "balance" which we computed may have been fortuitous. However, these calculations demonstrate that our values of net surface heat exchange are not inconsistent with independent estimates of temperature advection and diffusion.

SUMMARY AND CONCLUSIONS

Distributions of long-term composite monthly atmosphere-ocean heat exchange processes have been presented for the California Current region over a 1° latitude-longitude grid. The monthly fields represent summarizations of the radiative and turbulent heat fluxes computed from individual surface marine weather reports archived in the National Climatic Center's TDF-11 data file. This report complements the earlier work of Nelson (1977) who summarized wind stress and wind stress curl over the California Current region.

The climatological fields of surface heat fluxes provide insight to the important areas of heat gain and loss in the California Current. The region off the west coast of the United States and Baja California is characterized by net annual heat transfer from atmosphere to ocean. Maximum net oceanic heat gain occurs in the coastal upwelling zone off northern California as a consequence of relatively low cloud cover compared with offshore distributions, suppression of latent heat flux, and a reversal of the sensible heat transfer due to the presence of cold water during summer. These same features (i.e., maximum net oceanic heat gain, low cloudiness, and small turbulent fluxes in coastal upwelling regions) are evident in all major eastern boundary current systems (Hastenrath and Lamb 1978). Maximum heat loss occurs during winter off the Pacific Northwest. Simplified heat budget calculations demonstrate that our values of surface heat flux are not inconsistent with independent estimates of horizontal and vertical temperature advection and show the important contribution of advective processes in determining the seasonal heat balance in coastal upwelling regions.

Because of the heterogeneous character of the surface marine weather observations, relatively large errors are associated with empirical estimates of the radiative and turbulent heat fluxes. Nonrandom distributions of reports, sampling errors, fair-weather bias, and methods of computation introduce uncertainties which cast doubt on the validity of heat exchange estimates derived from merchant vessel data. Reasonable estimates of the error in each heat exchange component (e.g., 10%) lead to errors in the long-term mean net heat exchange, $\bar{Q}_N$, ranging from 10 to 70%. Our analyses indicate that the principal spatial and temporal features of surface heat flux over the California Current region (e.g., maximum oceanic heat gain near the coast during summer) are independent of computational methods which use monthly mean properties and variable exchange coefficients in the empirical formulae as opposed to individual observations and constant coefficients. Spectrum analyses of representative time series of $\bar{Q}_N$ show a general absence of variance at low frequencies and demonstrate the large signal-to-noise ratio of the annual cycle in midlatitude regions. The lack of coherence between time series in adjacent 1° squares is partially explained by the errors in monthly heat flux estimates, even in densely sampled areas.

The results of this study will be useful in modeling mean seasonal variations in the thermal structure of the California Current. For the purpose of indicating anomalies from the long-term means, however, further research in marine boundary layer processes is needed to place narrower confidence limits on the derived atmosphere-ocean exchanges. Because the largest relative errors are associated with heat exchange components which also have the largest absolute magnitudes (i.e., Q_S and Q_E), more extensive experimental studies in the open ocean and in the coastal boundary zone must be conducted 1) to improve the empirical formulae for short-wave radiation by using more objectively measured parameters (e.g., satellite observations of cloud cover), and 2) to evaluate the moisture flux parameterization for wider ranges of atmospheric stability and windspeed. With the increased application of air-sea interaction research to global climatic and fisheries problems, there is also an urgent requirement for consensus on the empirical formulae and methods of computation to be used. Although the absolute magnitudes of the long-term monthly mean values cannot be precisely fixed, the spatial and temporal consistency of independent estimates of surface heat exchange indicate that the geographical patterns (Appendix I) are realistic and significant.

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APPENDIX I

Monthly Surface Heat Flux Distributions

Long-term composite monthly mean surface heat flux distributions are displayed in Charts 1-60. Charts 1-12 are the monthly values of incident solar radiation corrected for cloud cover and reflection, Charts 13-24 the monthly effective back radiation, Charts 25-36 the monthly latent heat flux, Charts 37-48 the monthly sensible heat flux, and Charts 49-60 the monthly net heat exchange across the sea surface. Values are plotted in units of watts per square meter. The distributions are contoured with a contour interval of 25 W/m^2, except in Charts 13-24 and Charts 37-48 where a contour interval of 10 W/m^2 has been used. Positive values denote oceanic heat gain in Charts 1-12 and Charts 49-60 and oceanic heat loss in Charts 13-48. Negative values are shaded and indicate heat transfer from atmosphere to ocean in Charts 37-48 and heat loss from ocean to atmosphere in Charts 49-60.

The month is indicated in the figure legend in the upper right corner of the charts. The long-term mean monthly values were computed for the approximate time period 1921 to 1972. Scattered reports were available between 1921 and 1940 but the bulk of the data was collected after 1945. The coastline configuration is superimposed on the grid as a visual aid and does not represent a conformal mapping.

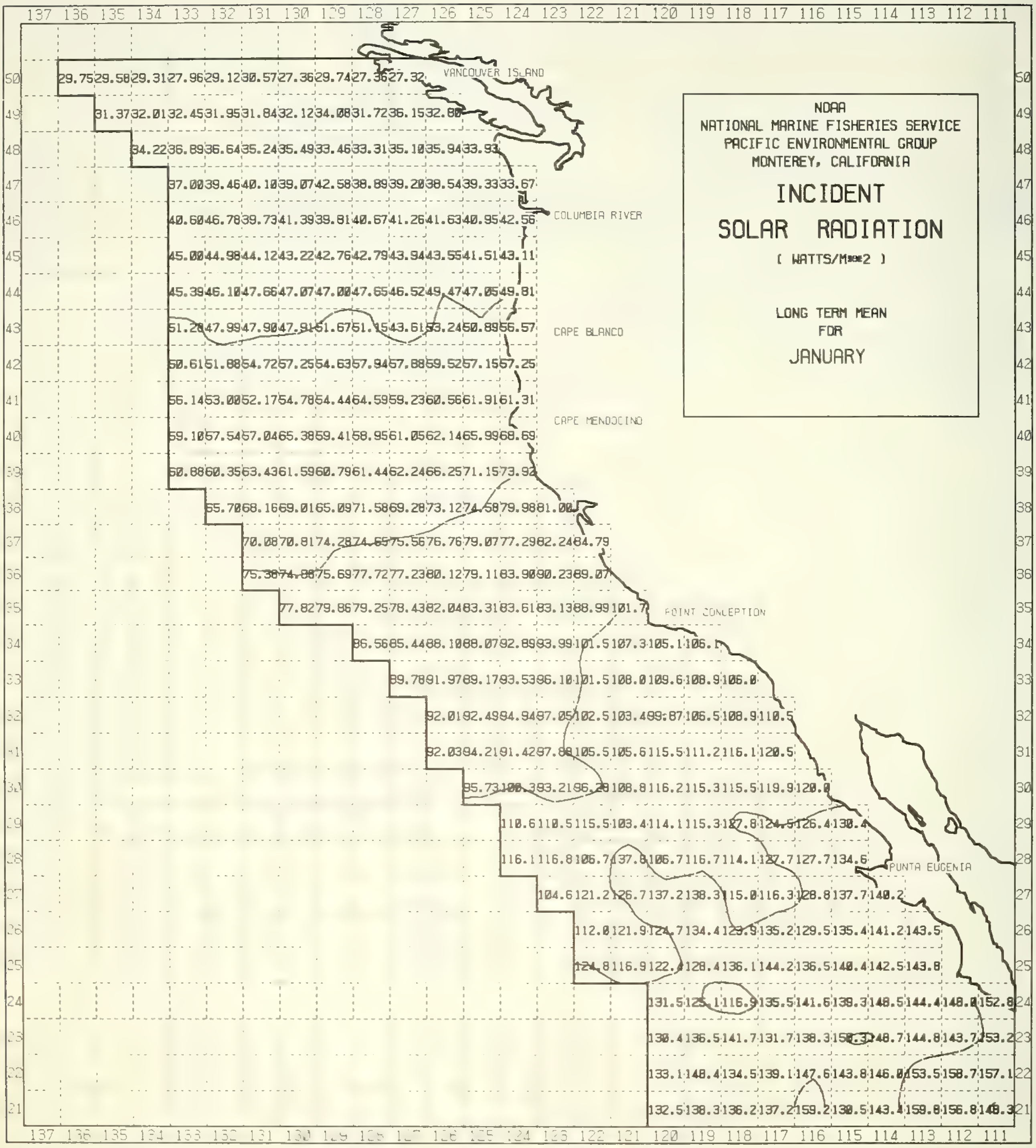

Chart 1.—Composite monthly mean incident solar radiation for January.

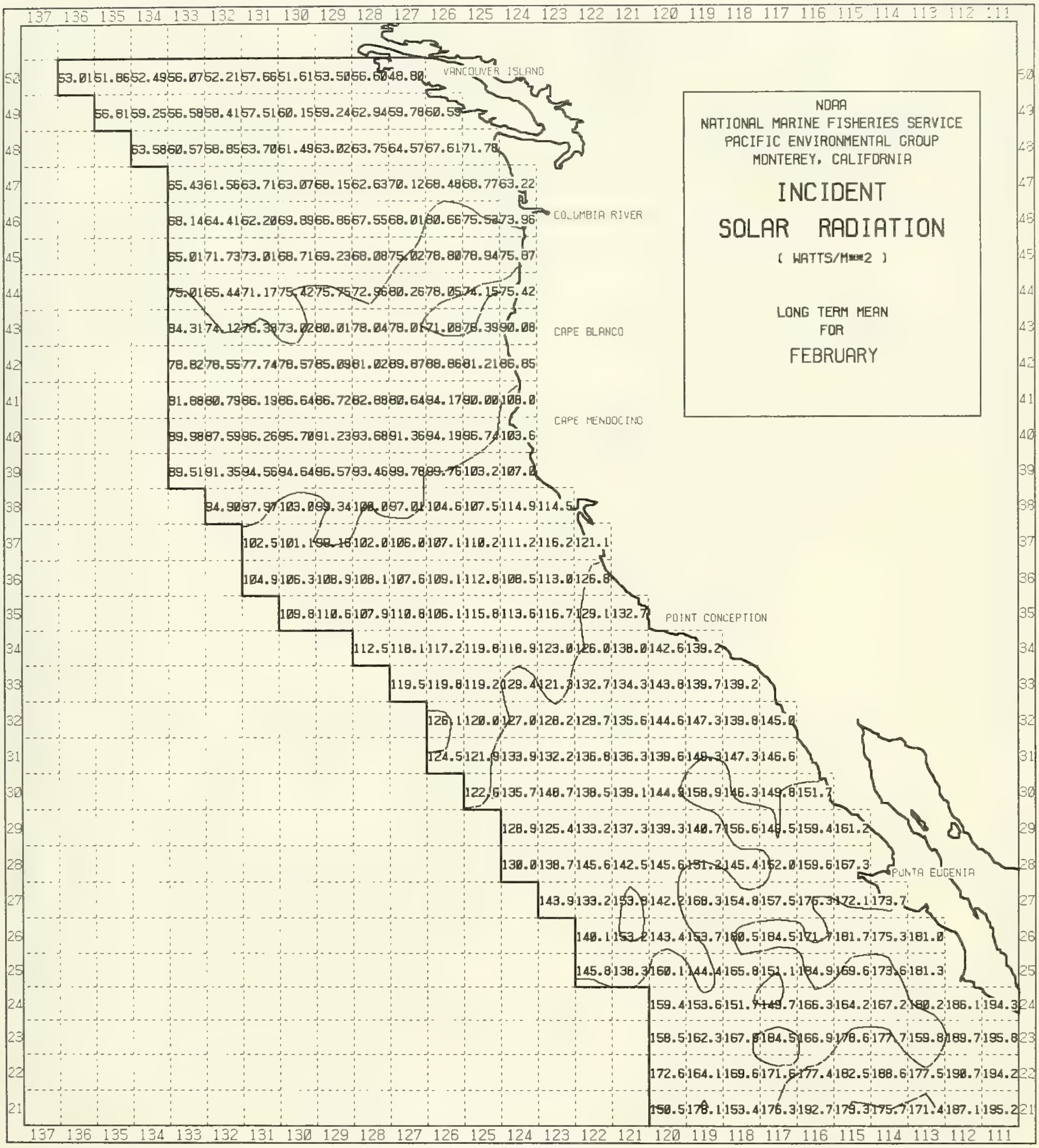

Chart 2.—Composite monthly mean incident solar radiation for February.

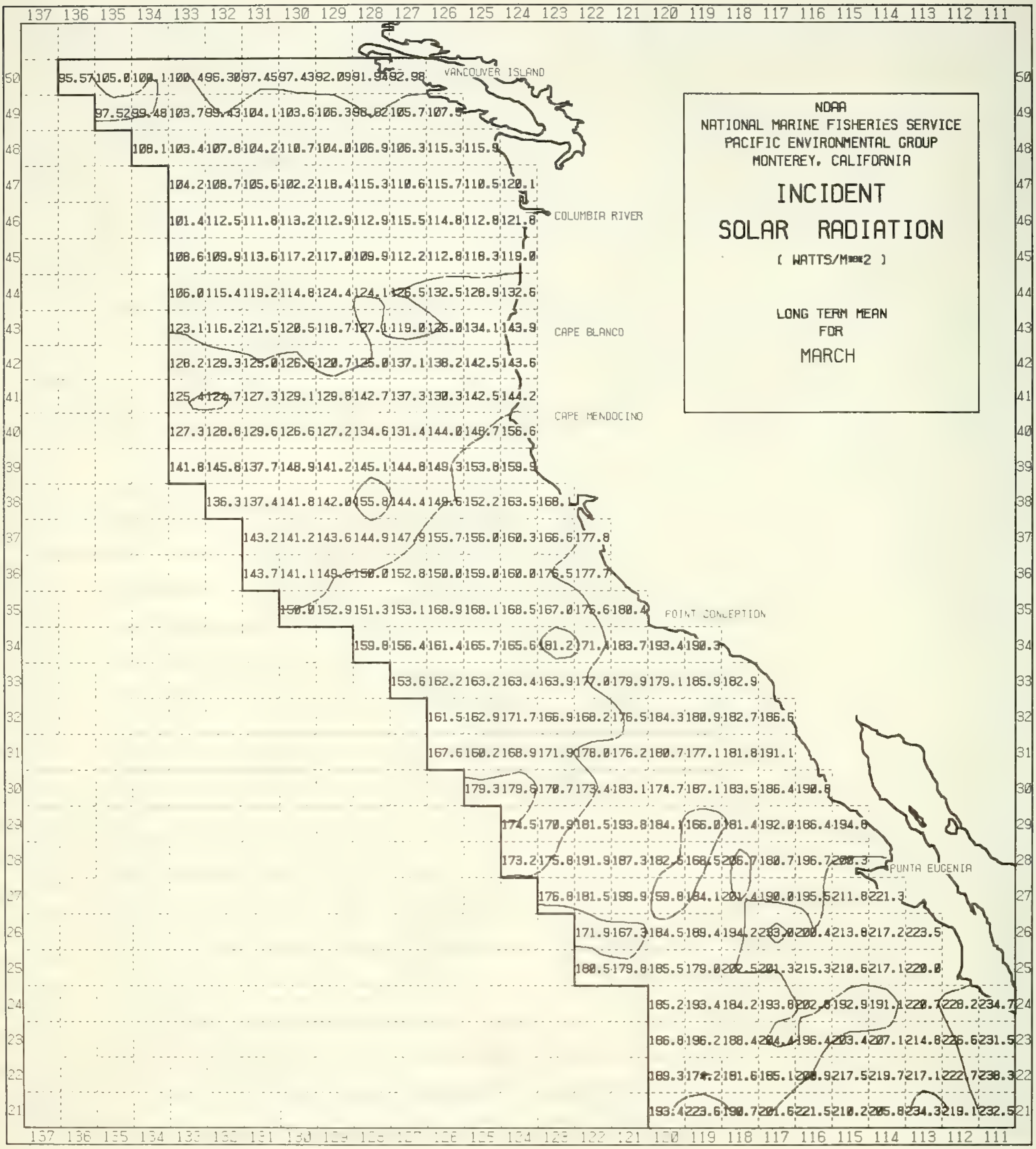

Chart 3.—Composite monthly mean incident solar radiation for March.

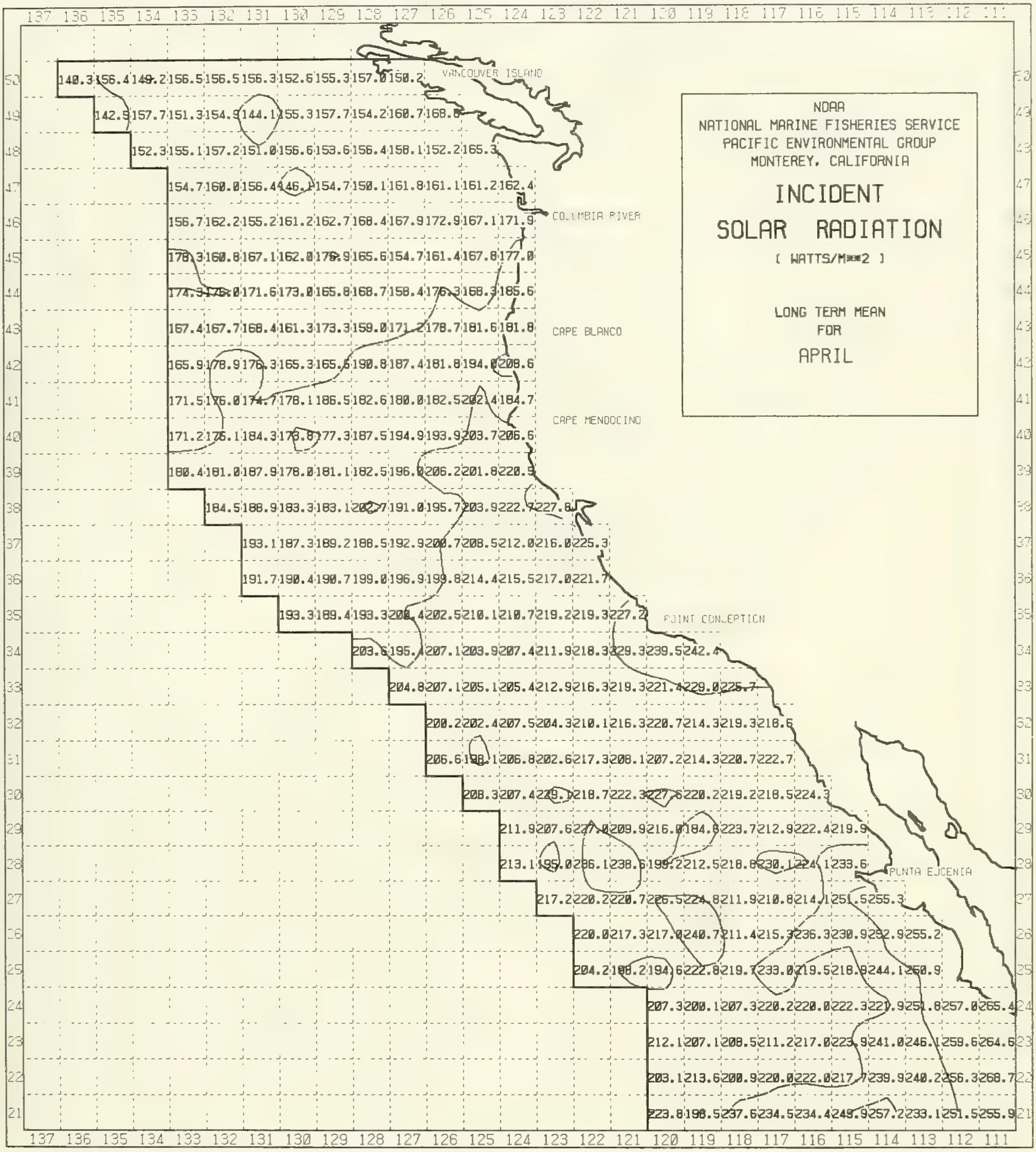

Chart 4.—Composite monthly mean incident solar radiation for April.

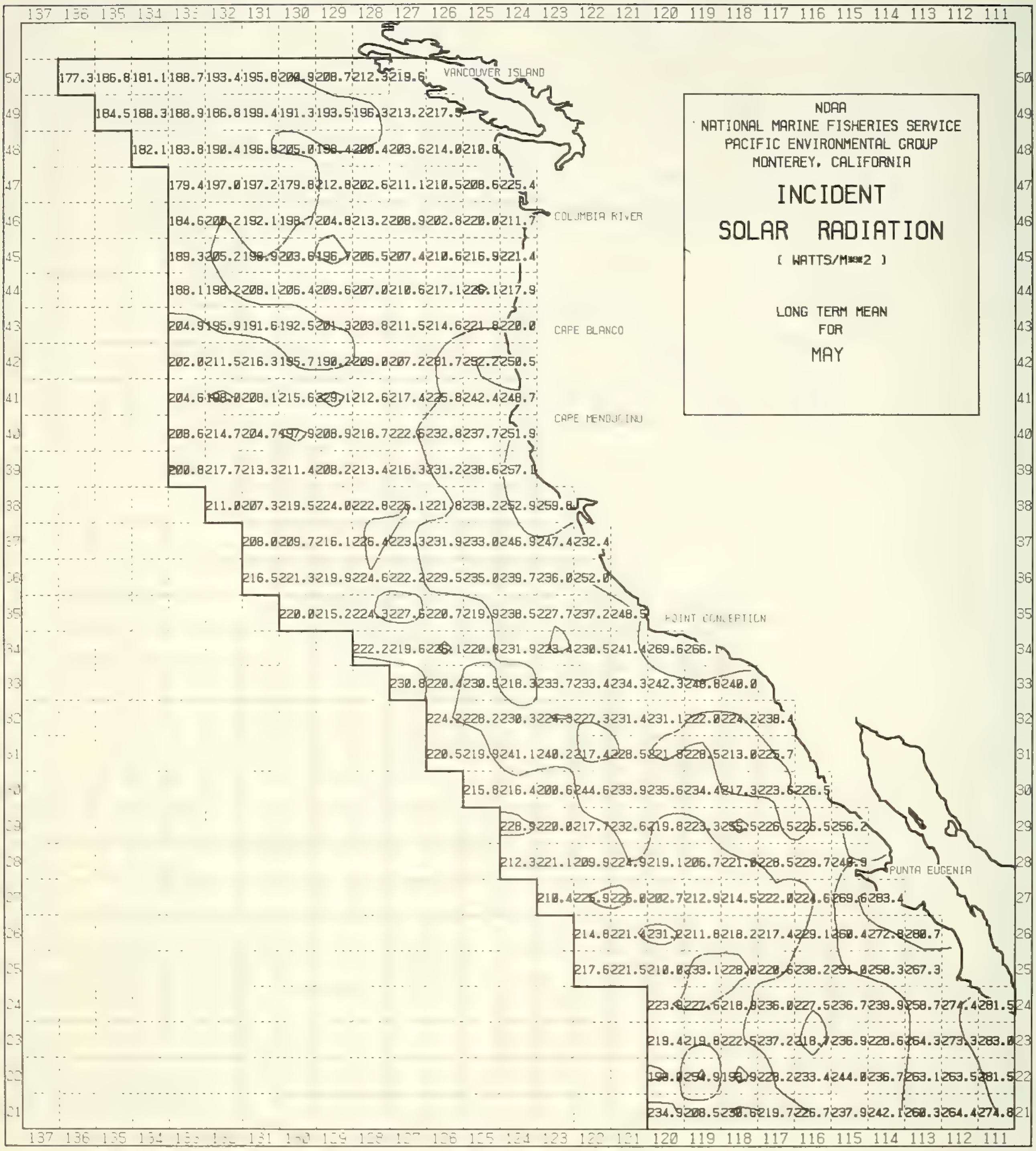

Chart 5.—Composite monthly mean incident solar radiation for May.

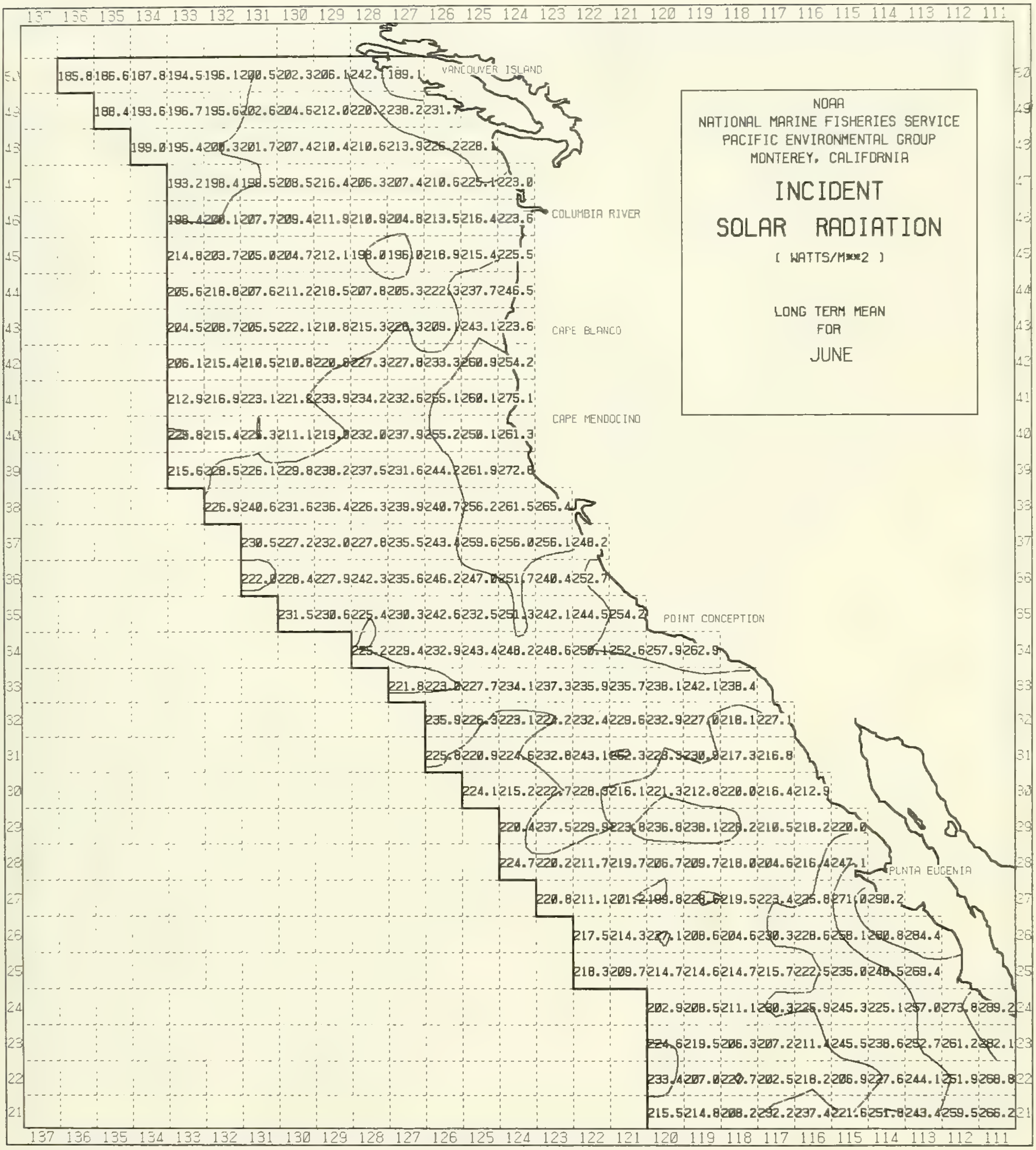

Chart 6.—Composite monthly mean incident solar radiation for June.

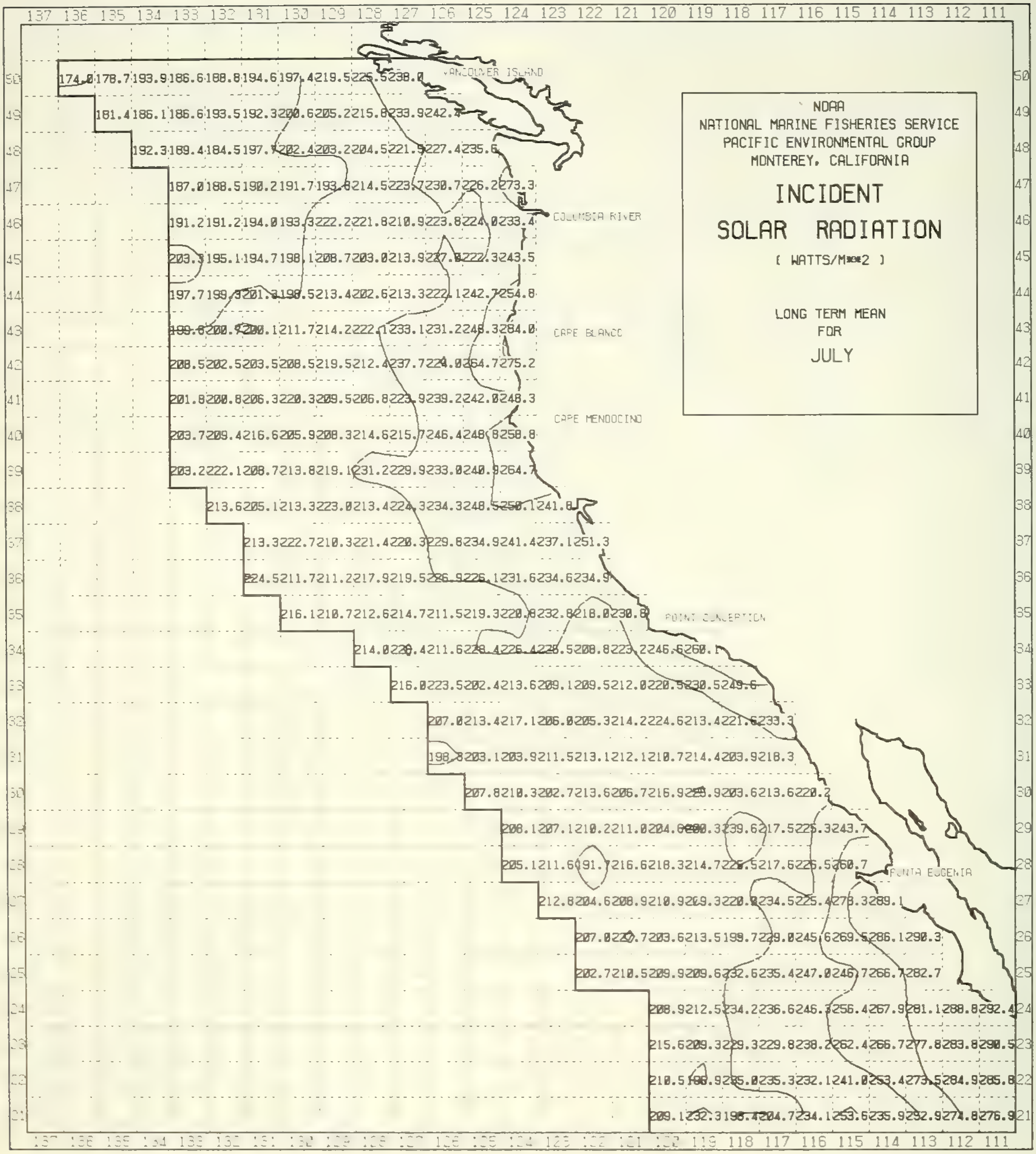

Chart 7.—Composite monthly mean incident solar radiation for July.

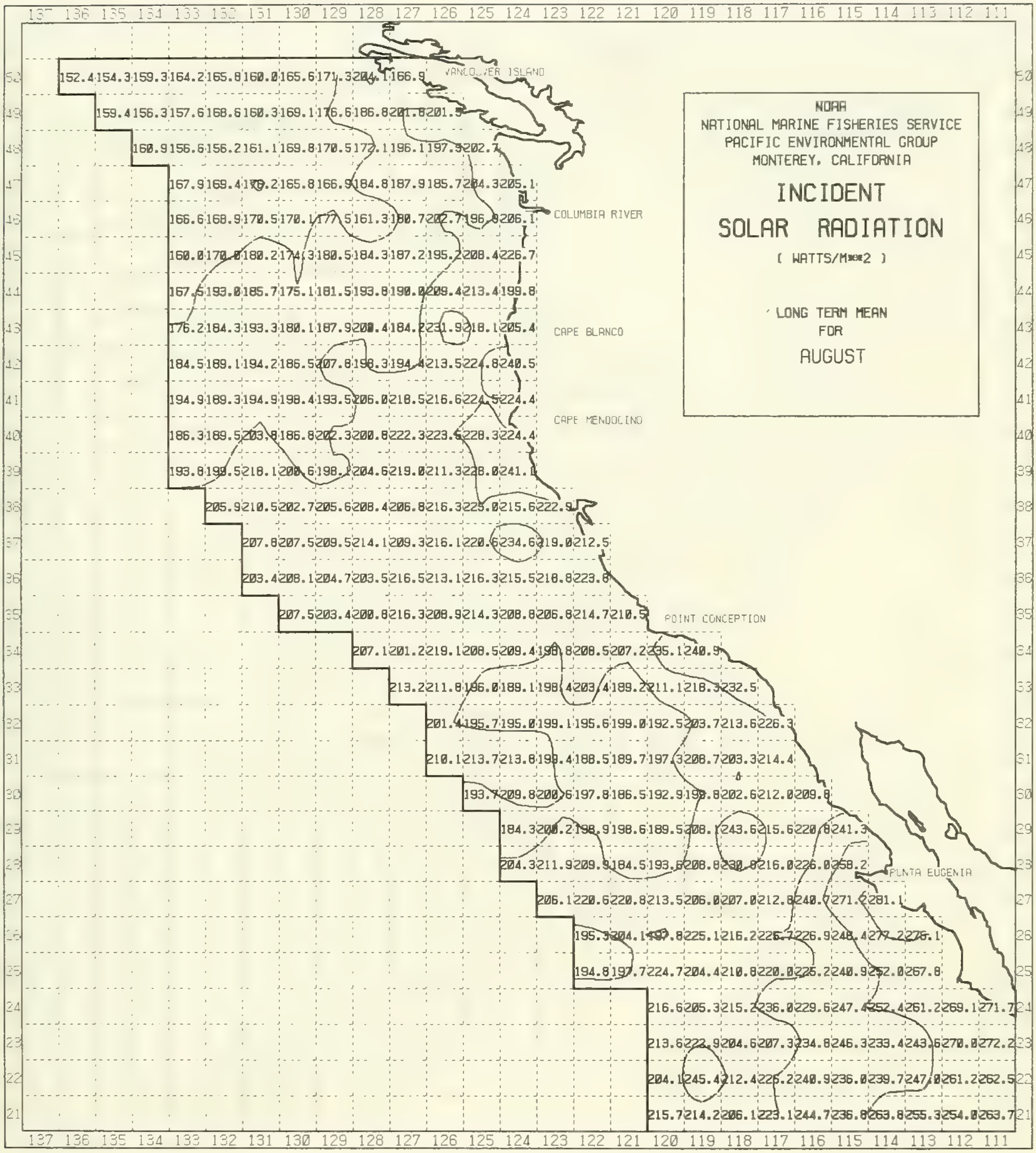

Chart 8.—Composite monthly mean incident solar radiation for August.

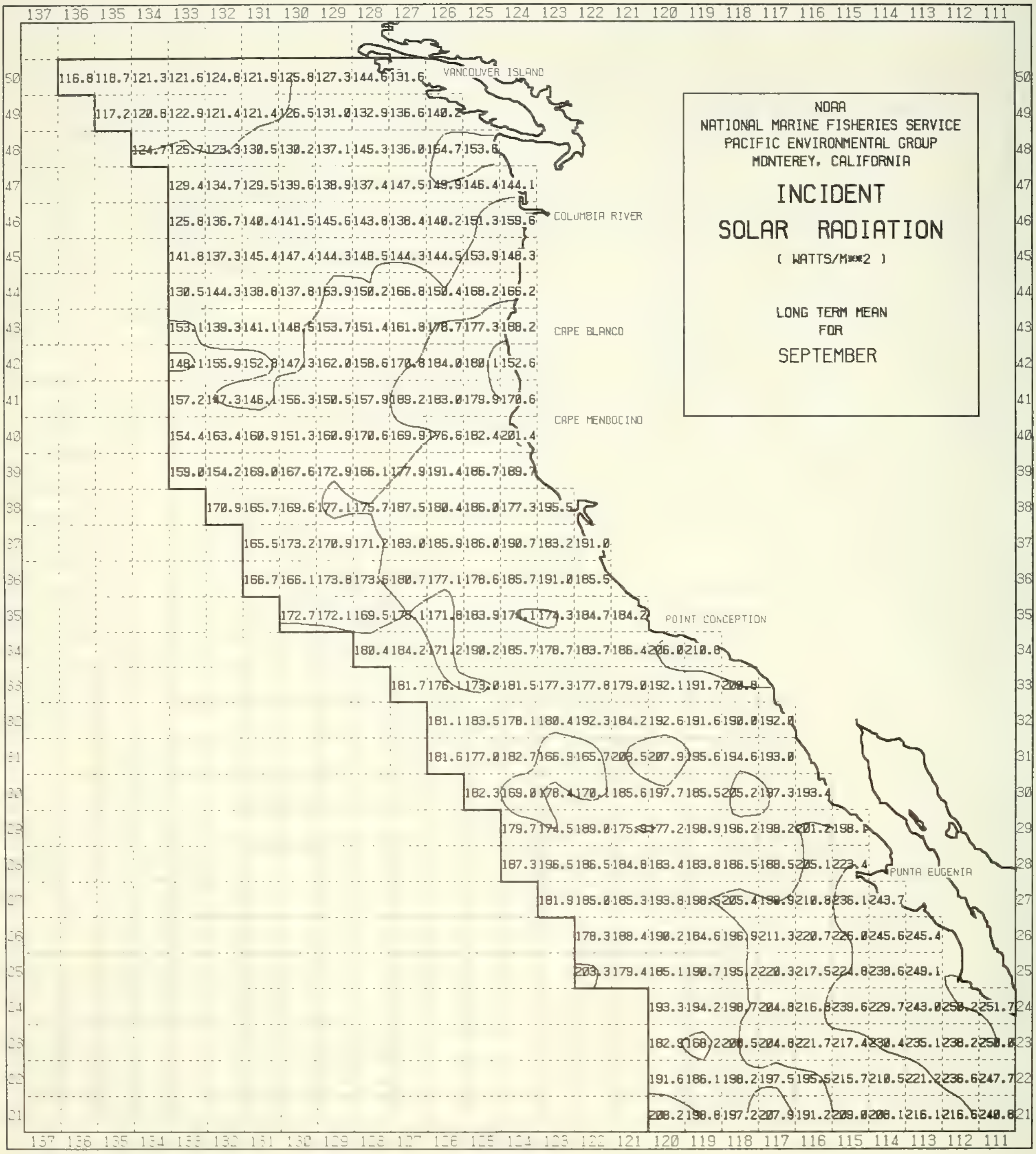

Chart 9.—Composite monthly mean incident solar radiation for September.

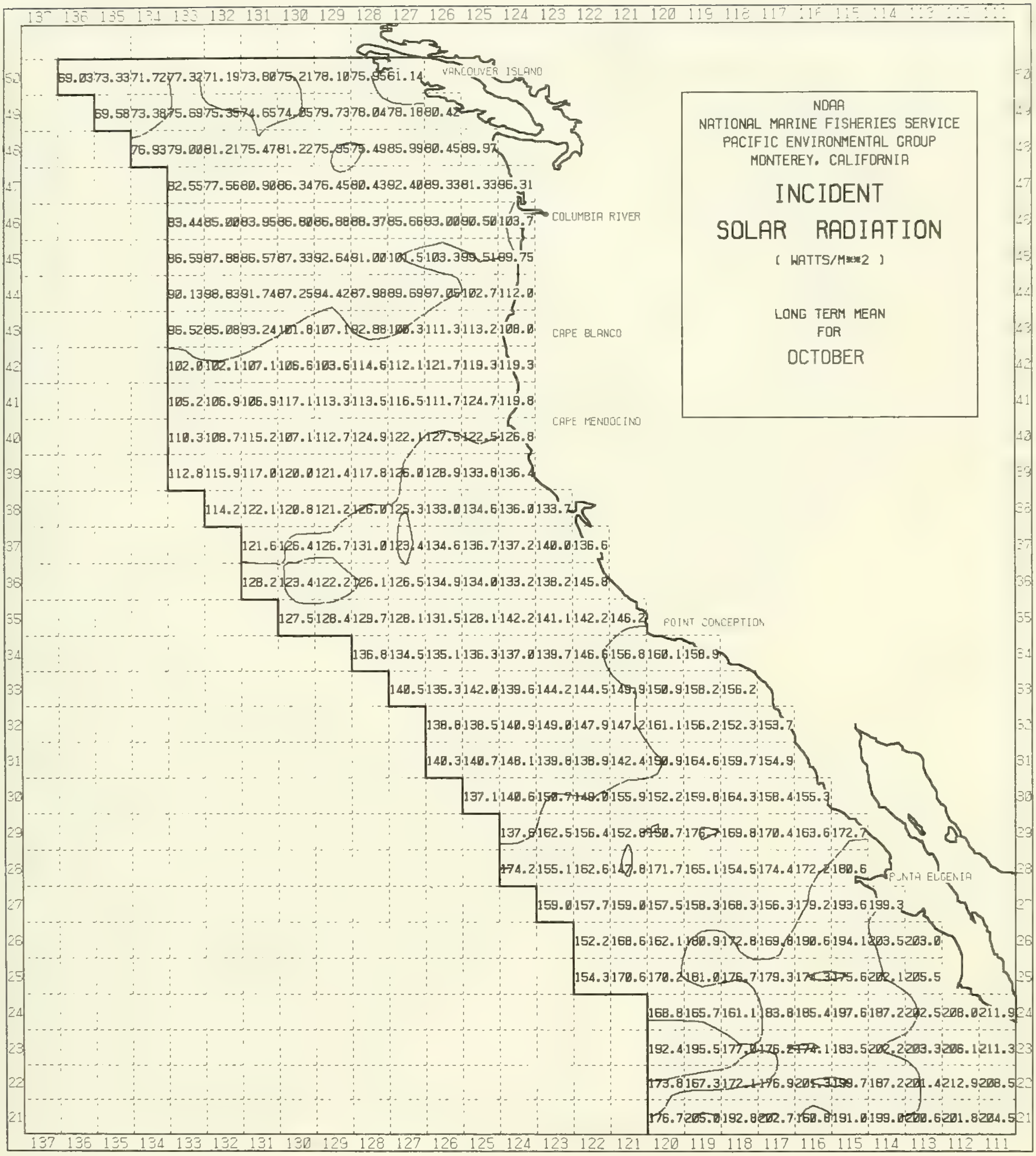

Chart 10.—Composite monthly mean incident solar radiation for October.

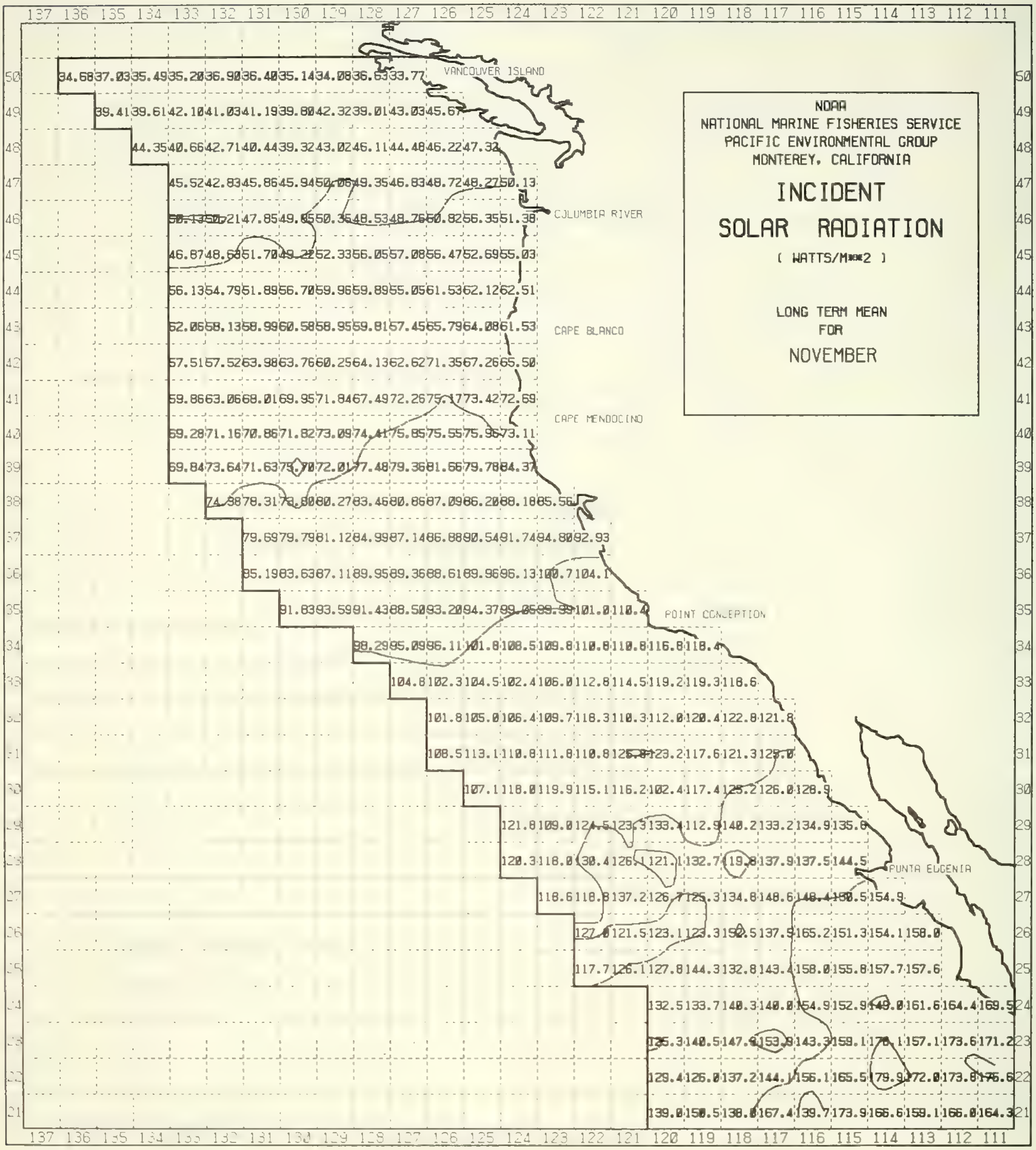

Chart 11.—Composite monthly mean incident solar radiation for November.

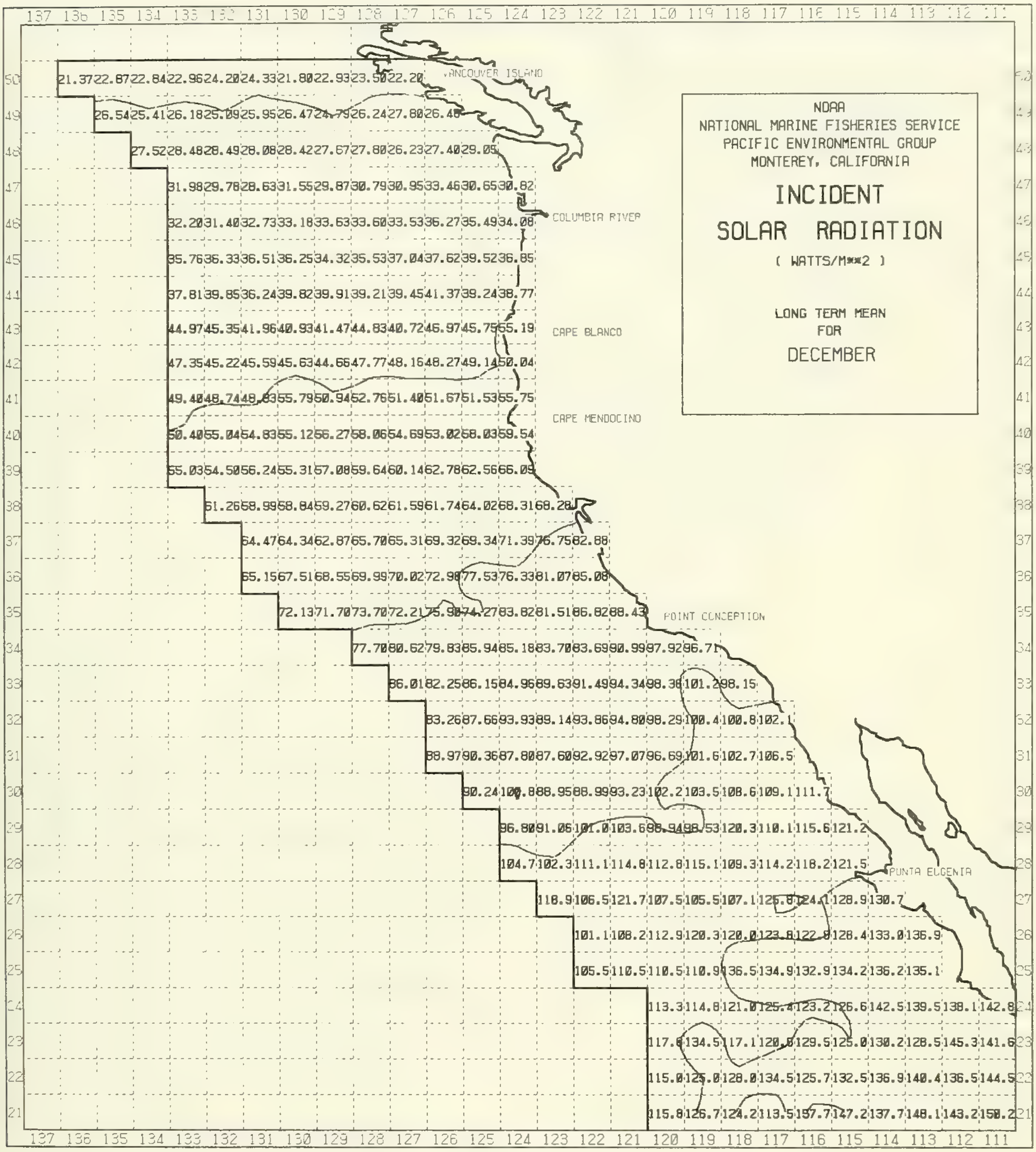

Chart 12.—Composite monthly mean incident solar radiation for December.

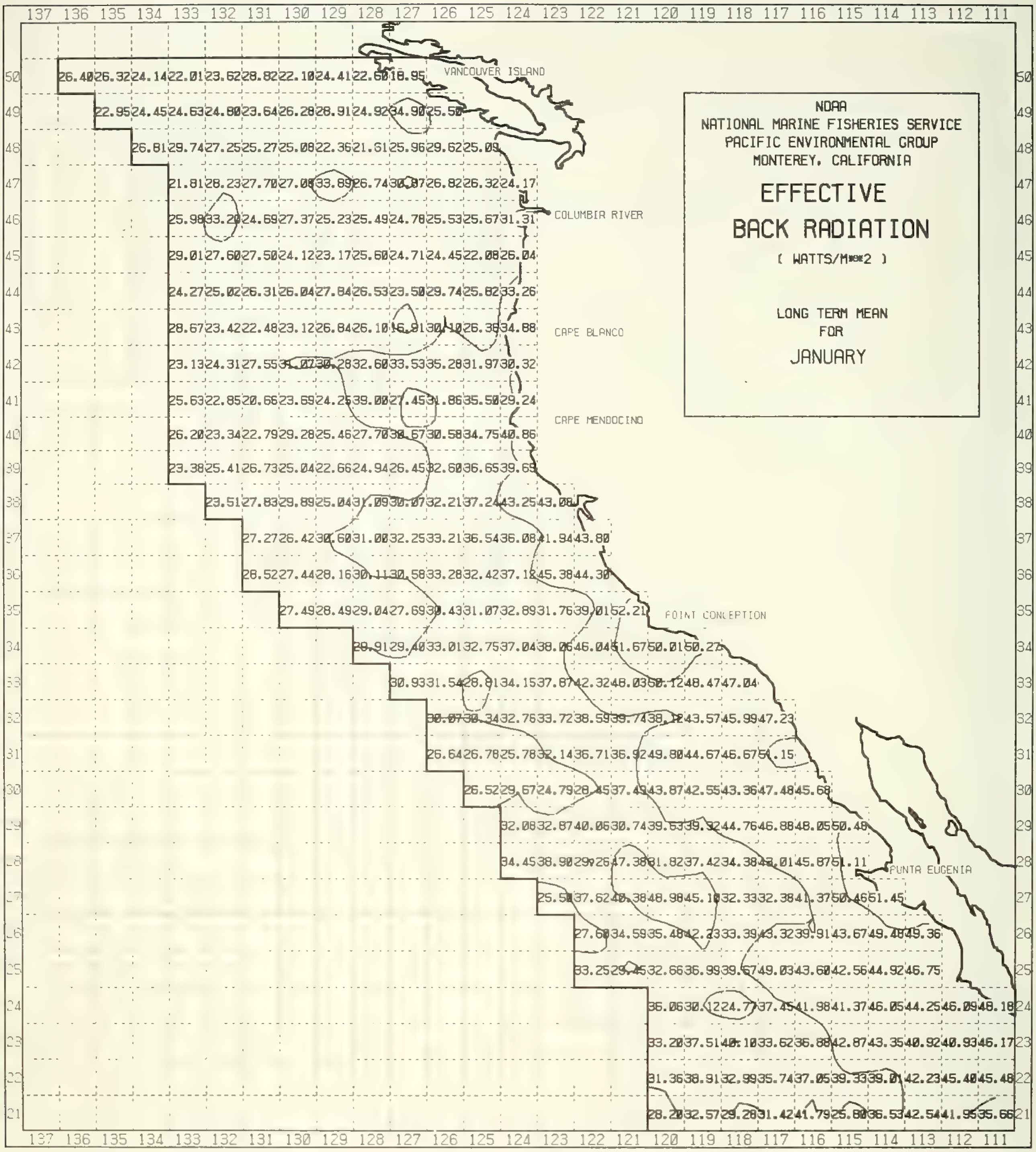

Chart 13.—Composite monthly mean effective back radiation for January.

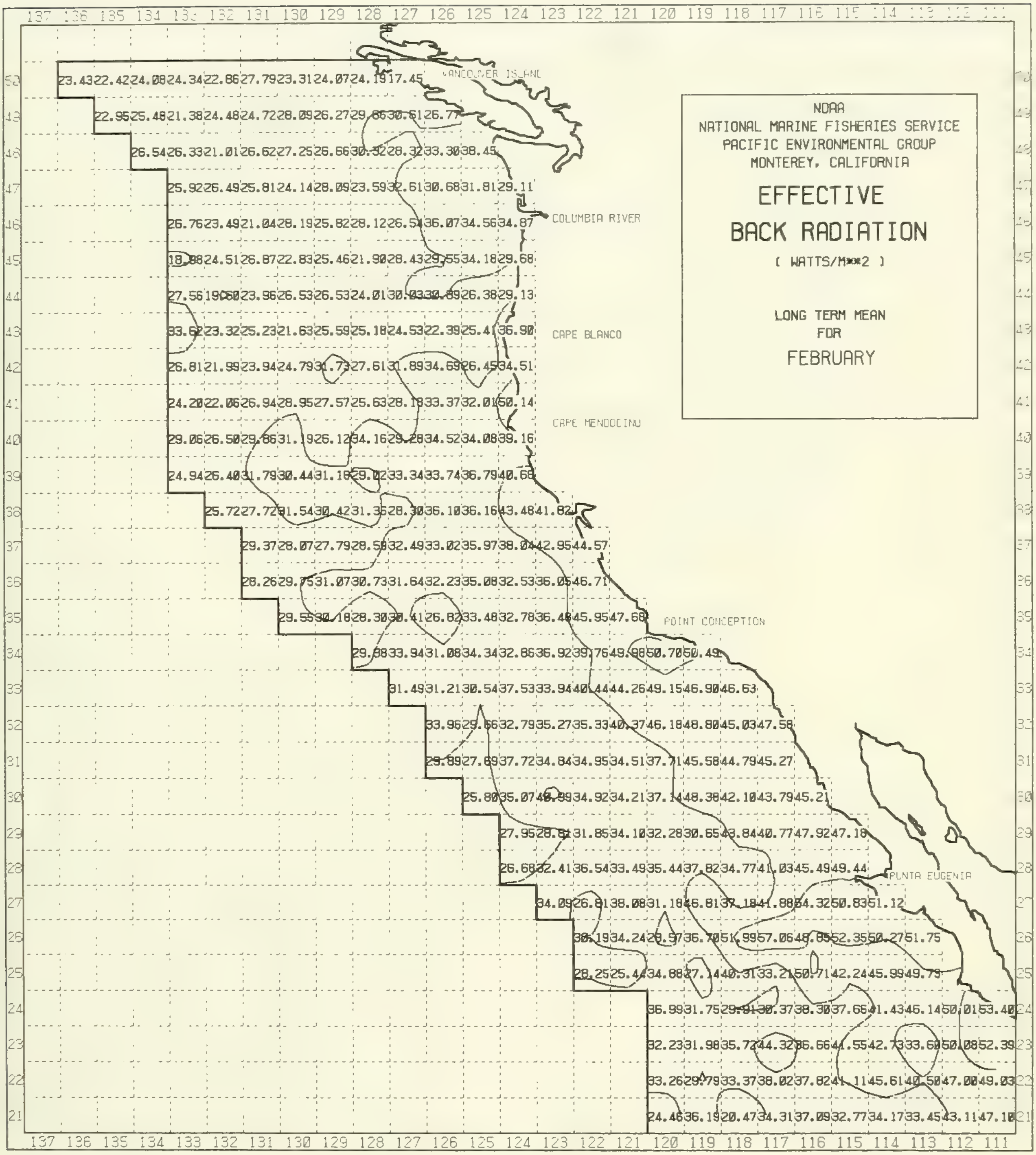

Chart 14.—Composite monthly mean effective back radiation for February.

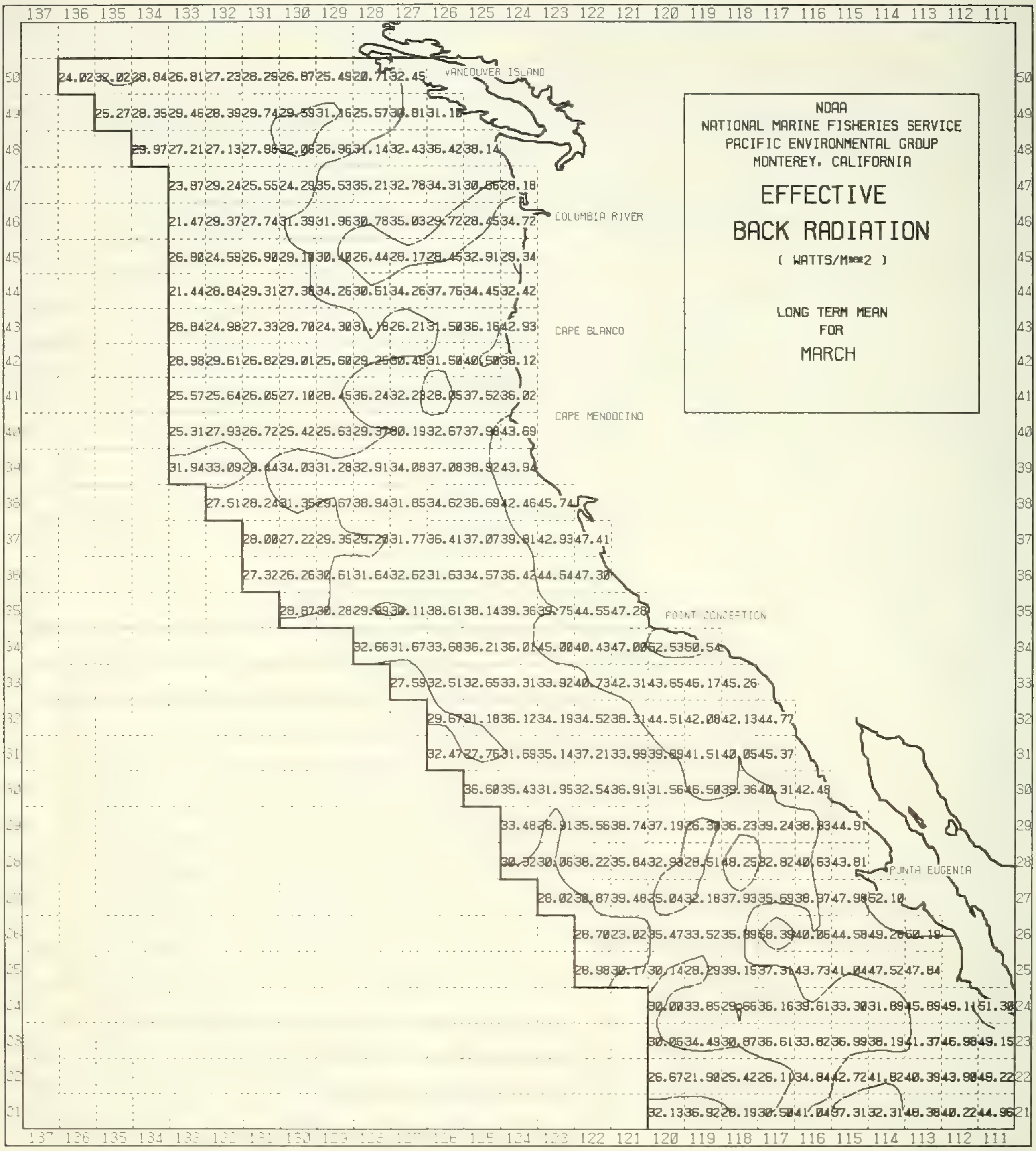

Chart 15.—Composite monthly mean effective back radiation for March.

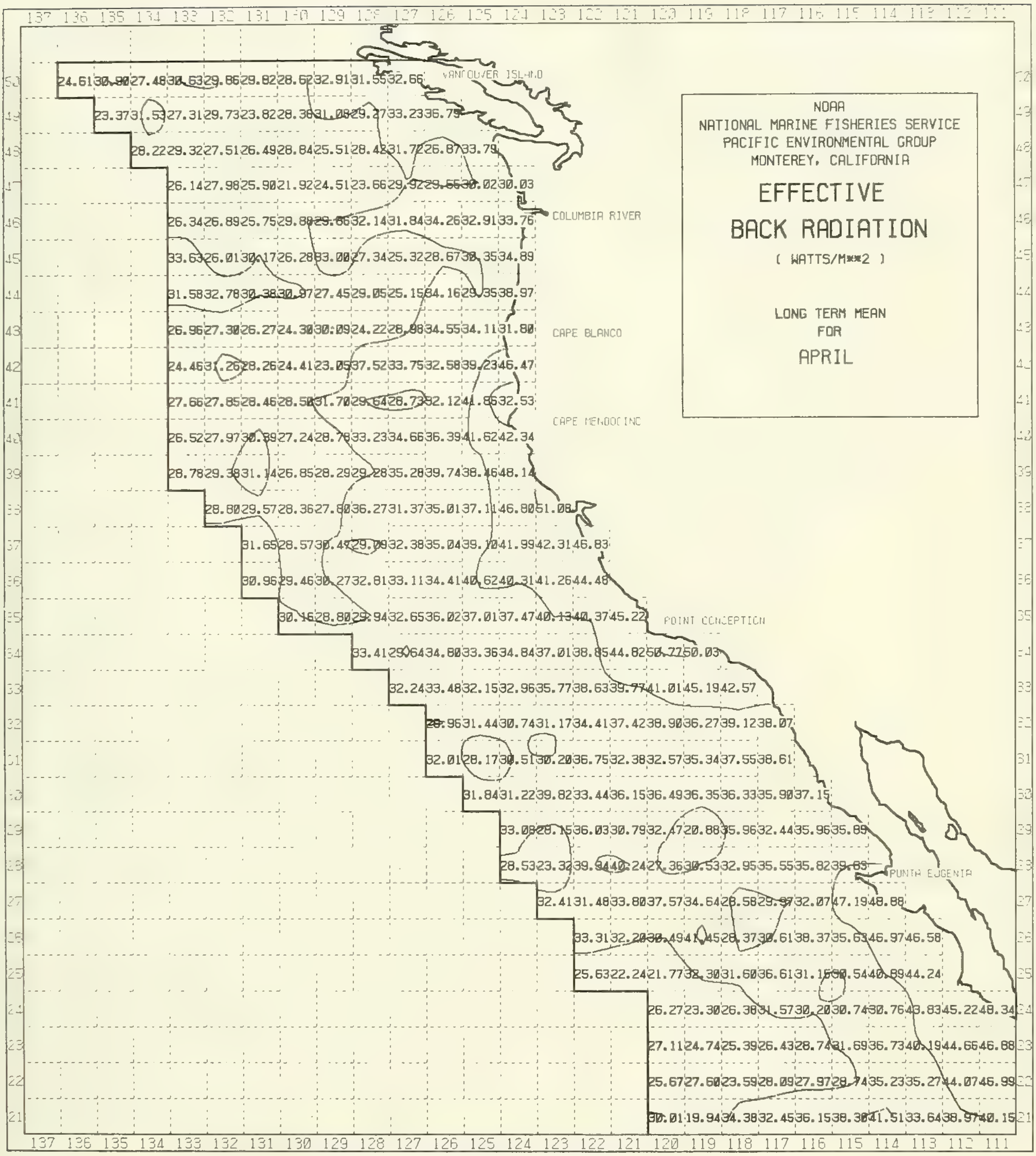

Chart 16.—Composite monthly mean effective back radiation for April.

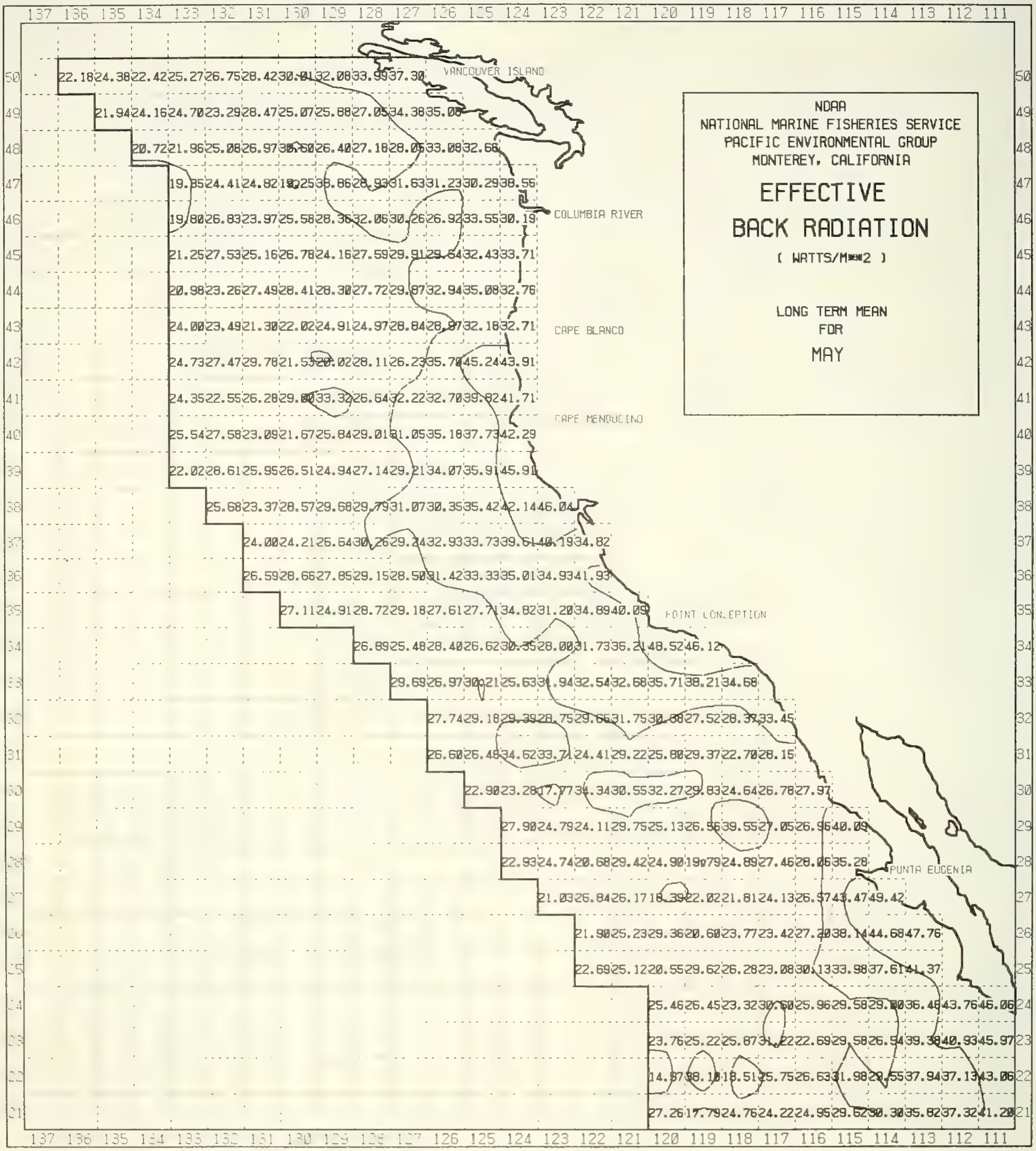

Chart 17.—Composite monthly mean effective back radiation for May.

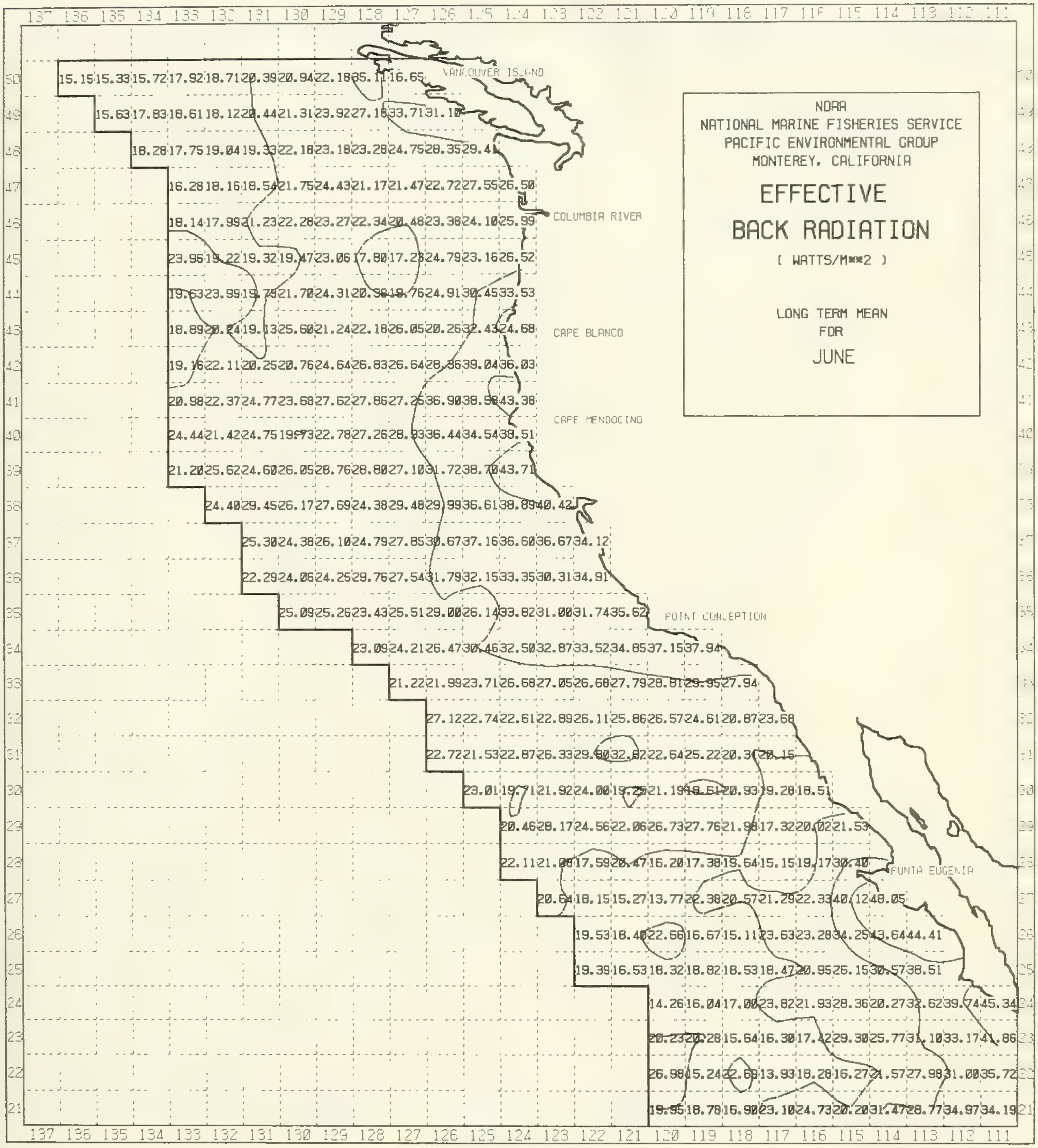

Chart 18.—Composite monthly mean effective back radiation for June.

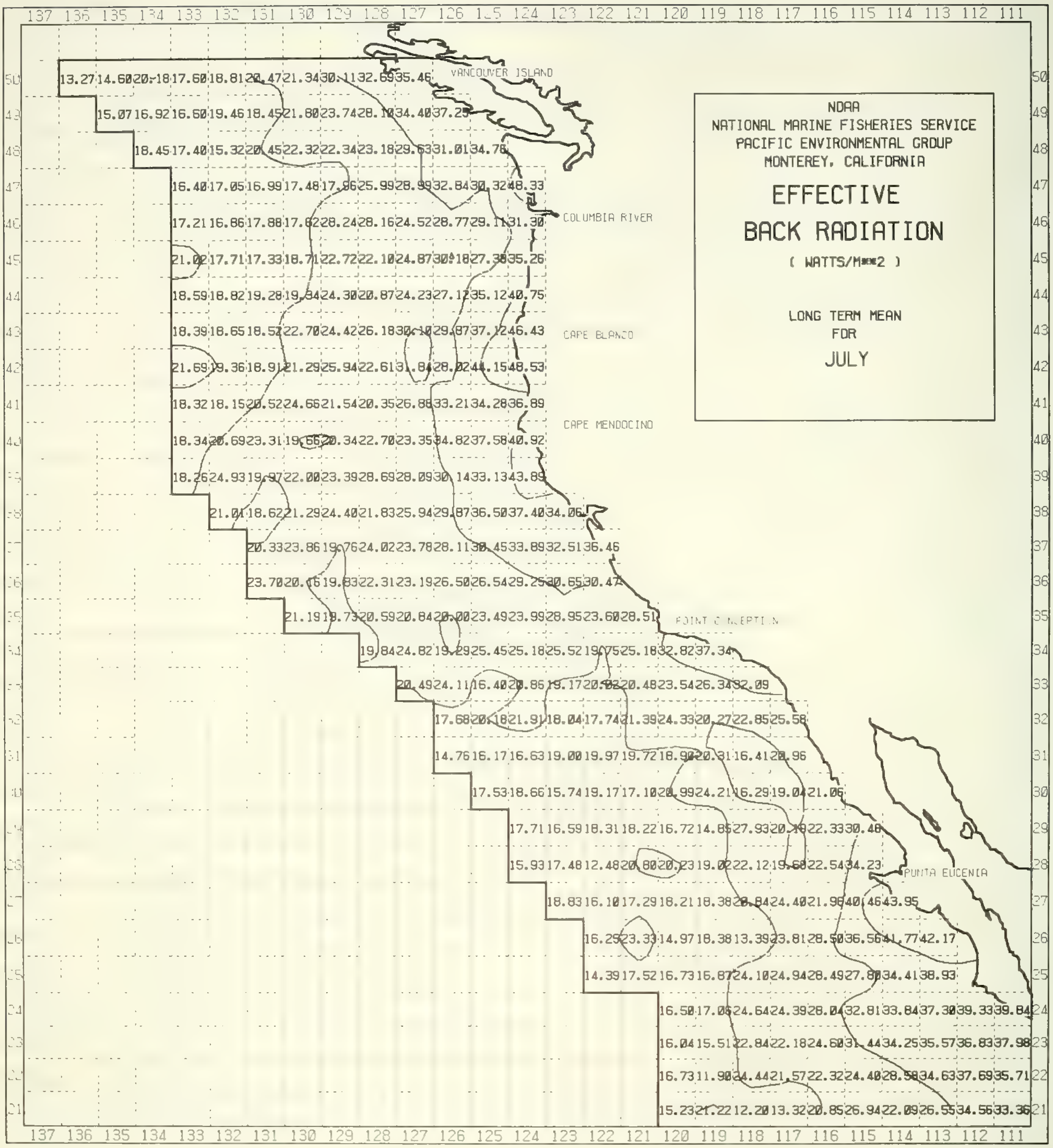

Chart 19.—Composite monthly mean effective back radiation for July.

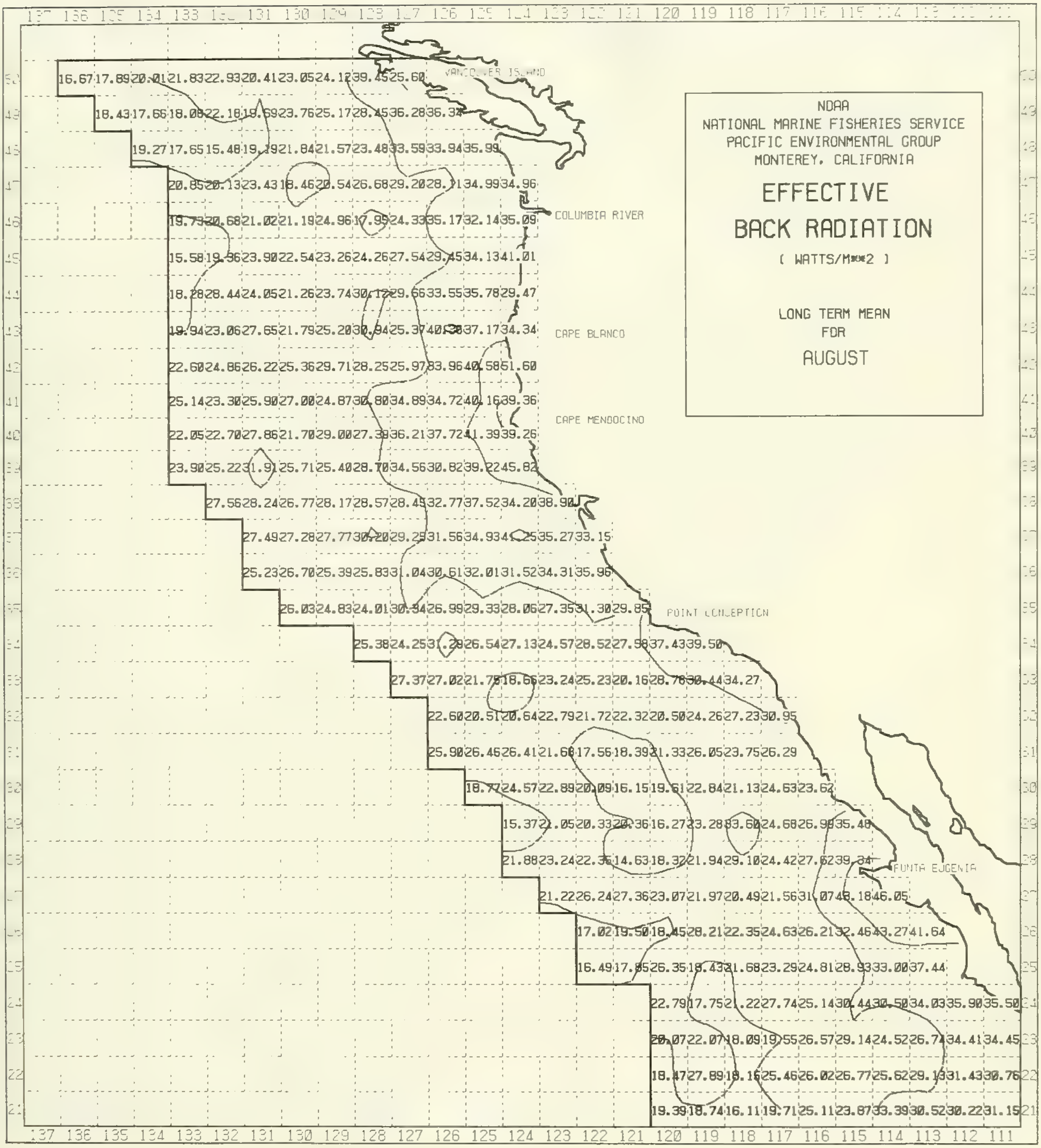

Chart 20.—Composite monthly mean effective back radiation for August.

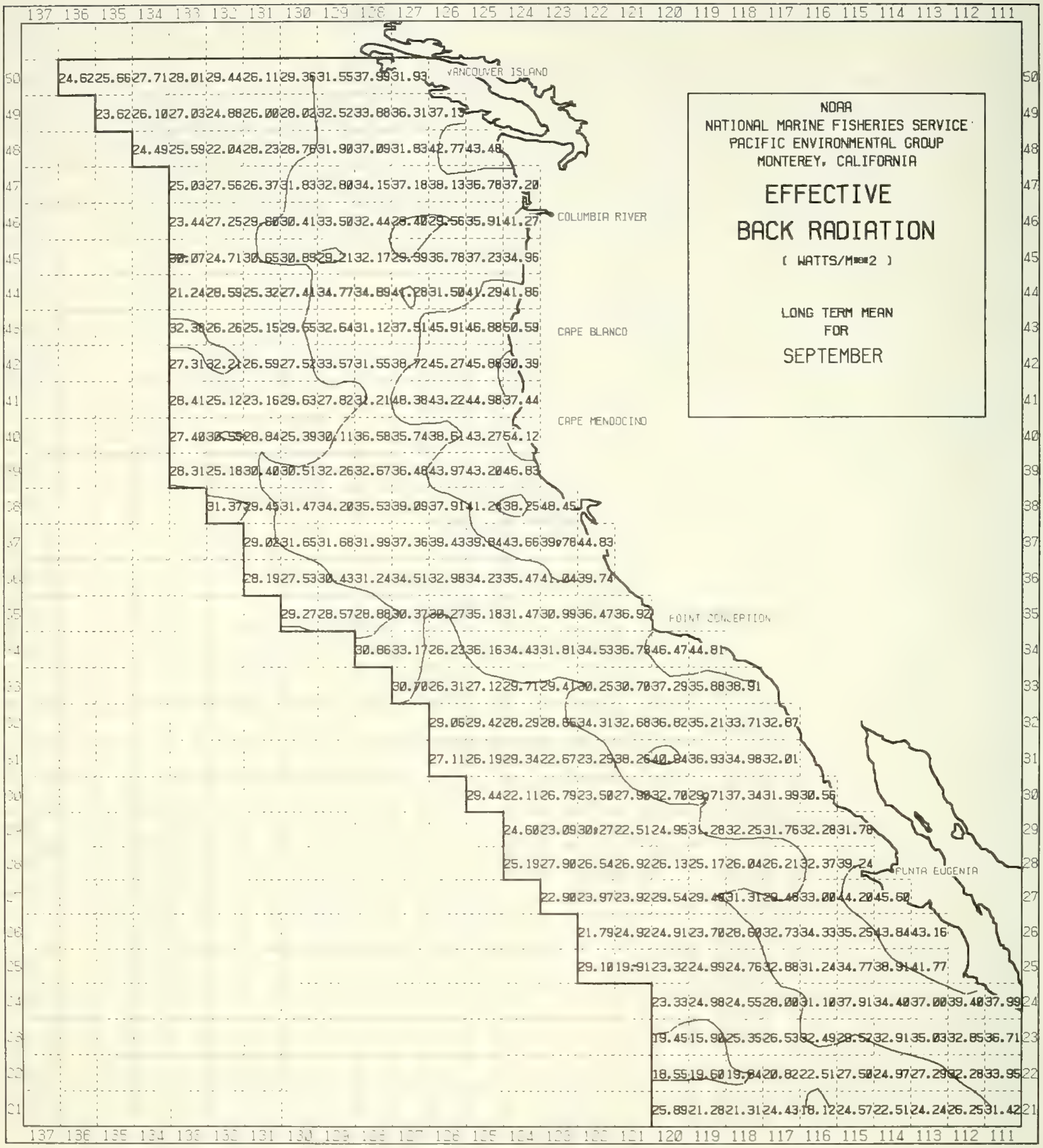

Chart 21.—Composite monthly mean effective back radiation for September.

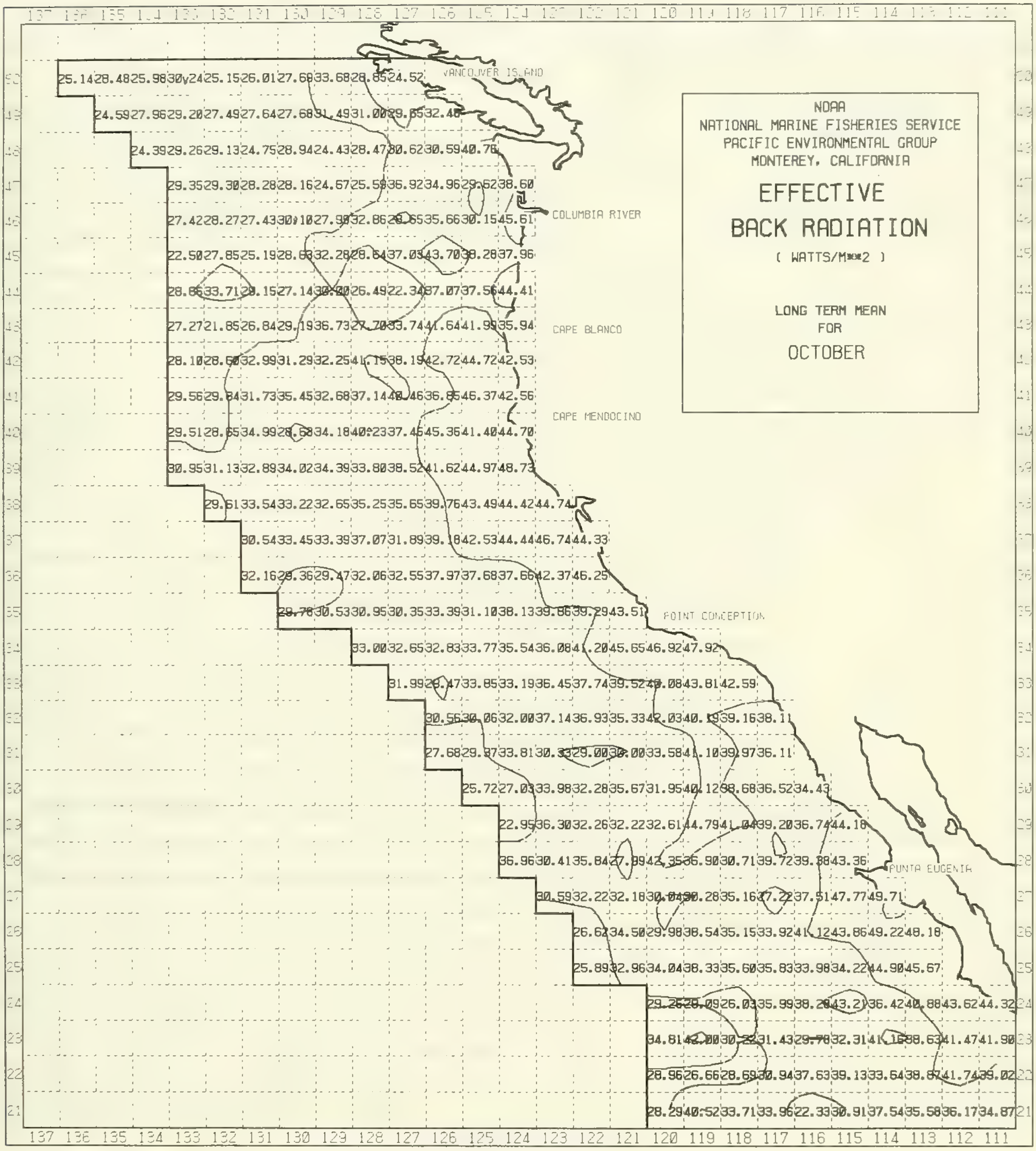

Chart 22.—Composite monthly mean effective back radiation for October.

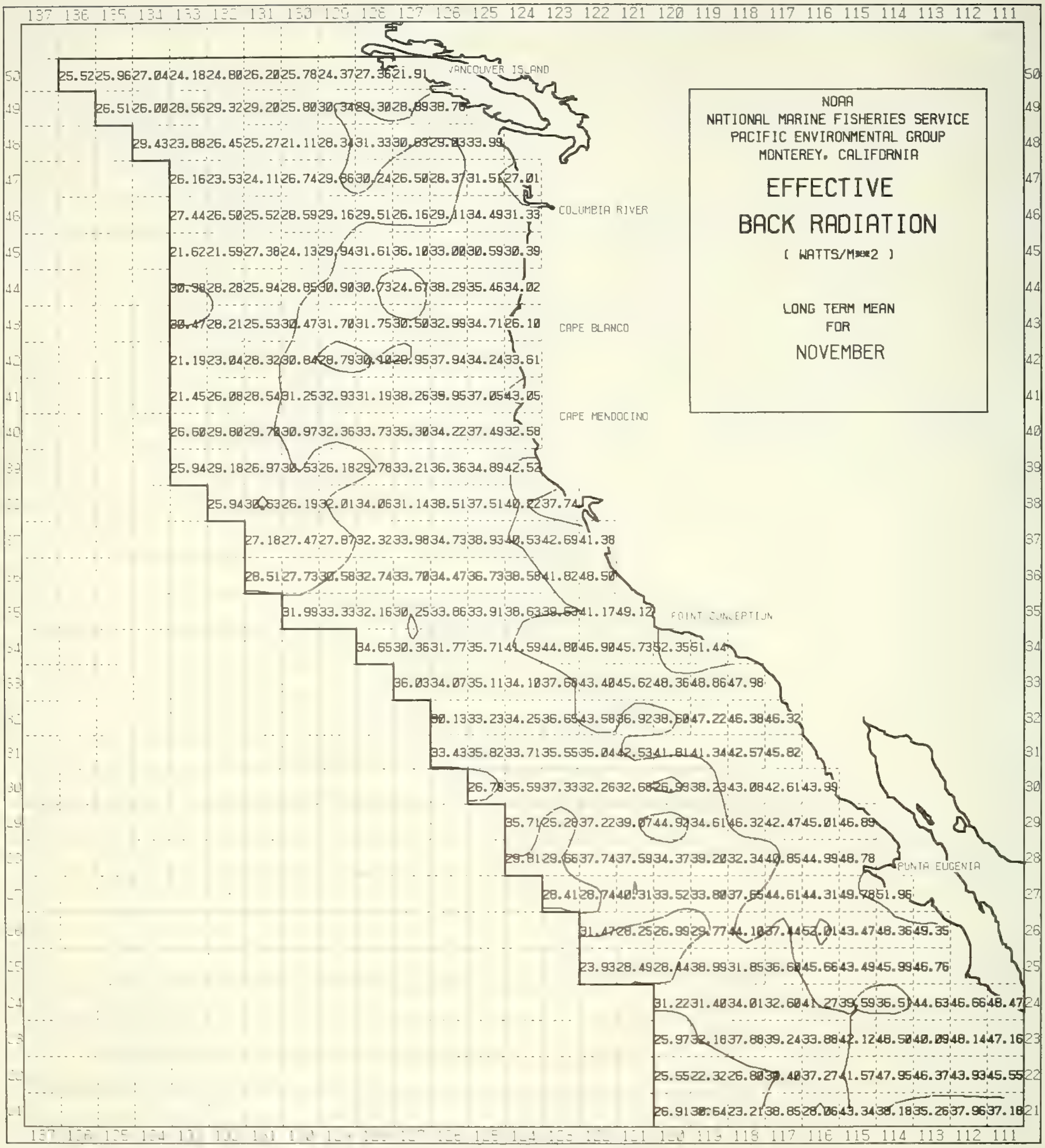

Chart 23.—Composite monthly mean effective back radiation for November.

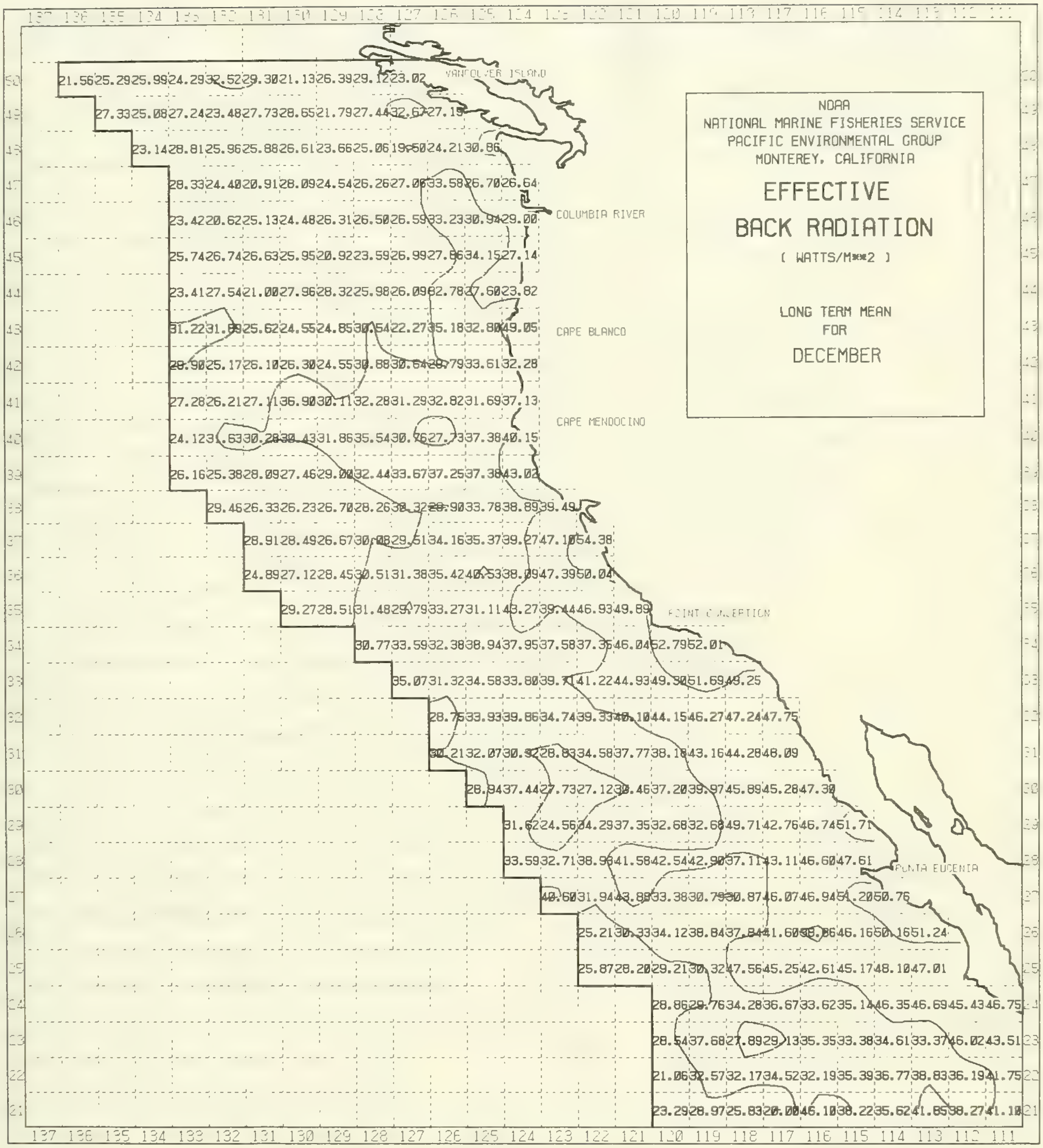

Chart 24.—Composite monthly mean effective back radiation for December.

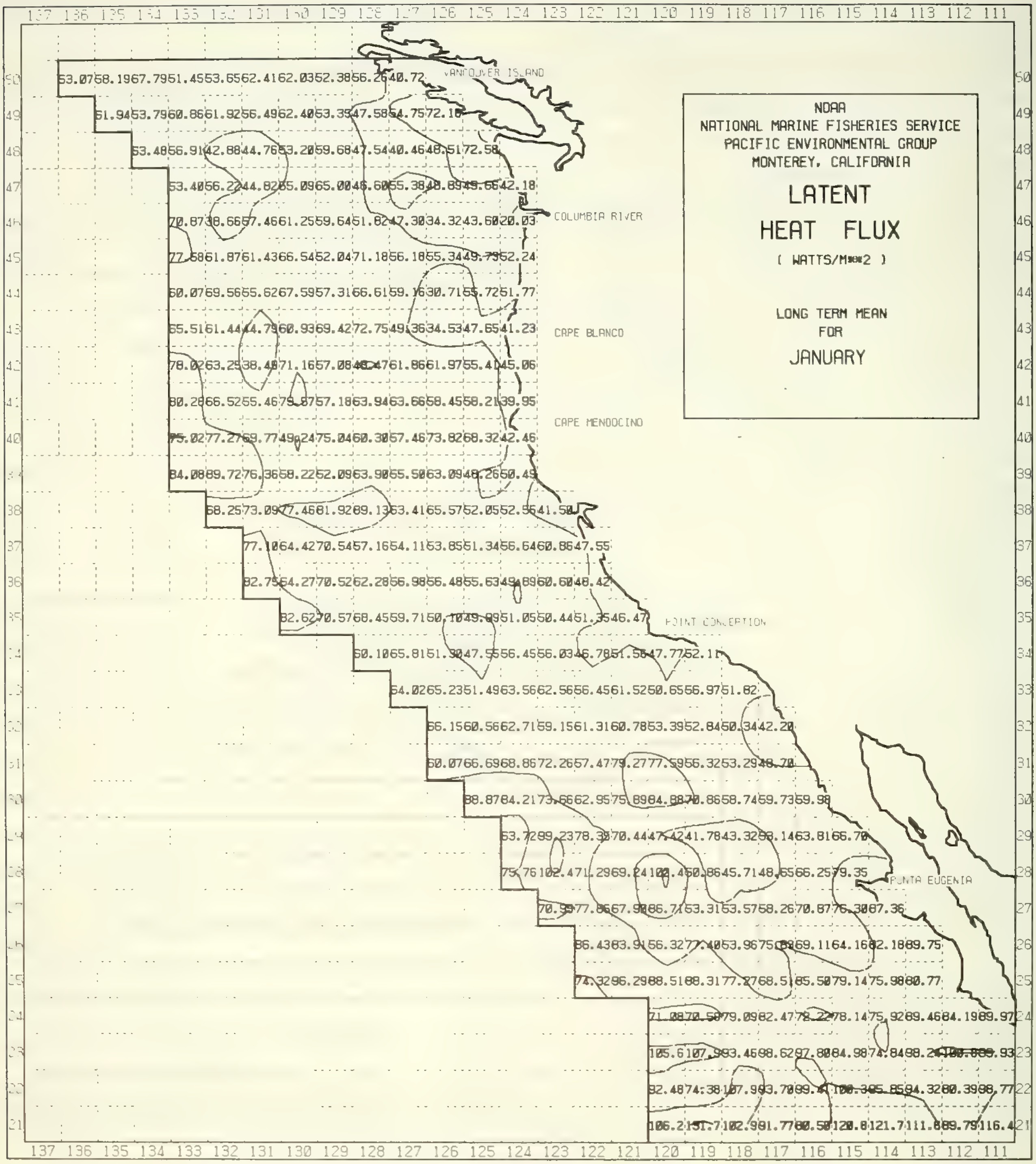

Chart 25.—Composite monthly mean latent heat flux for January.

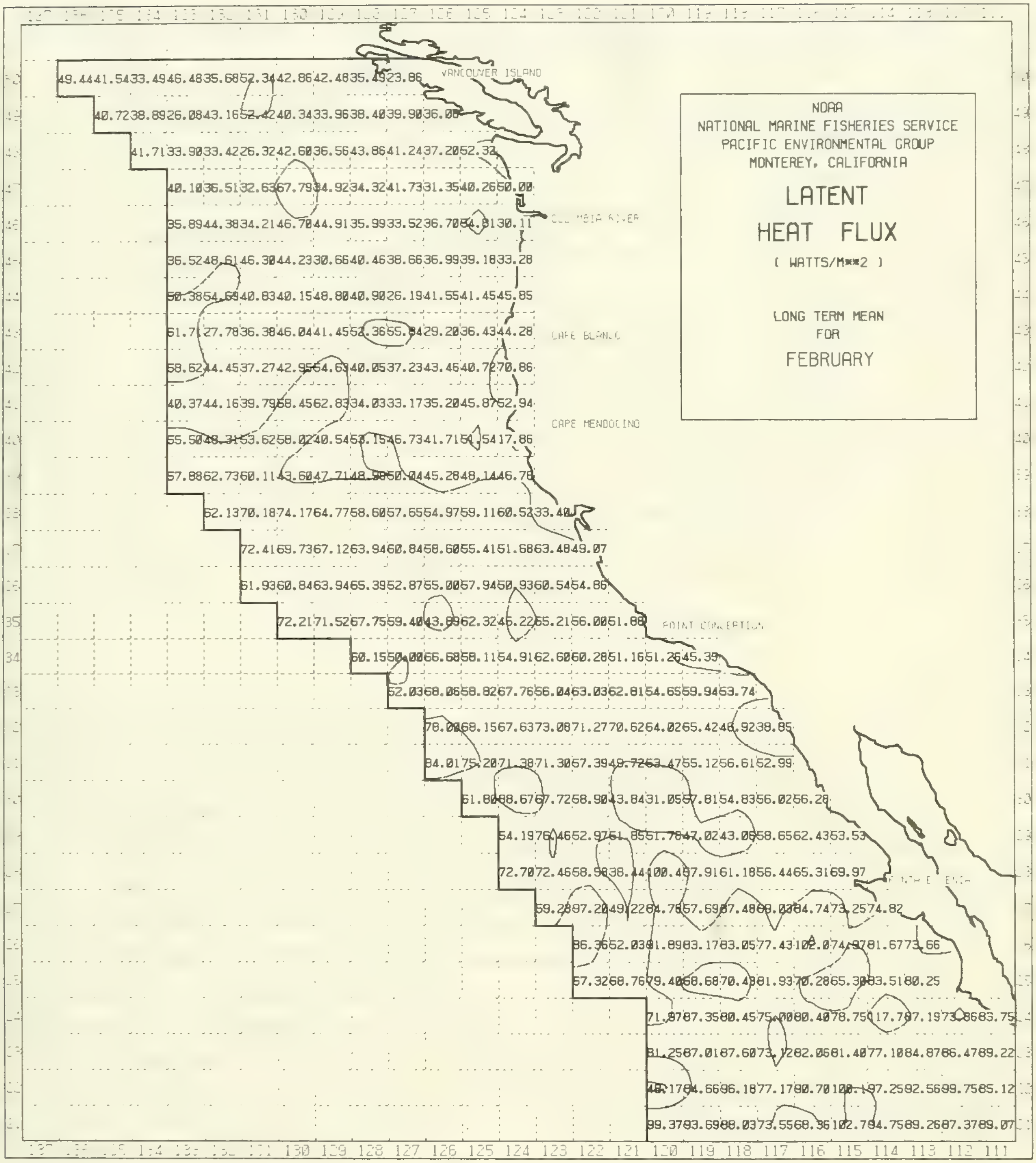

Chart 26.—Composite monthly mean latent heat flux for February.

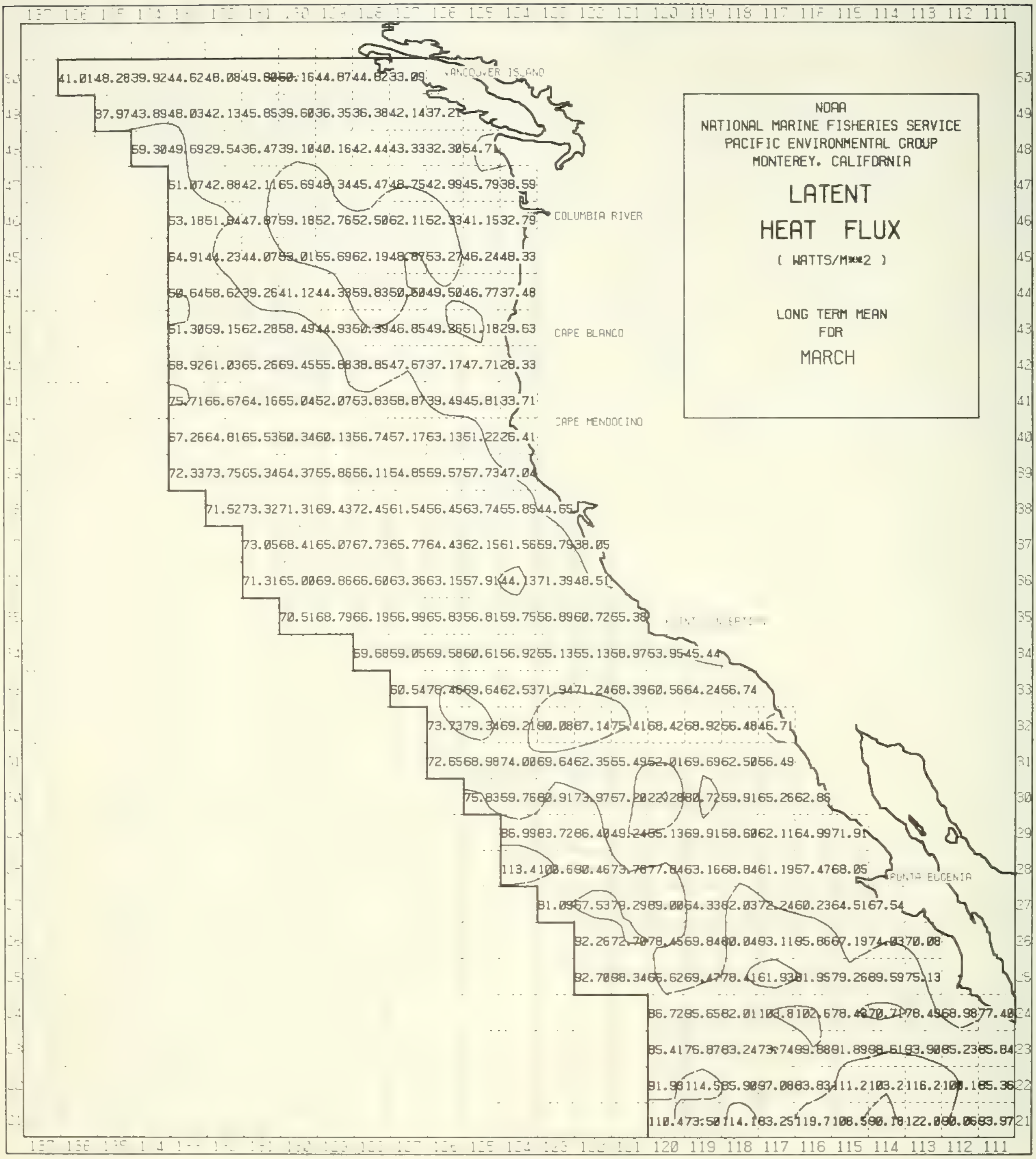

Chart 27.—Composite monthly mean latent heat flux for March.

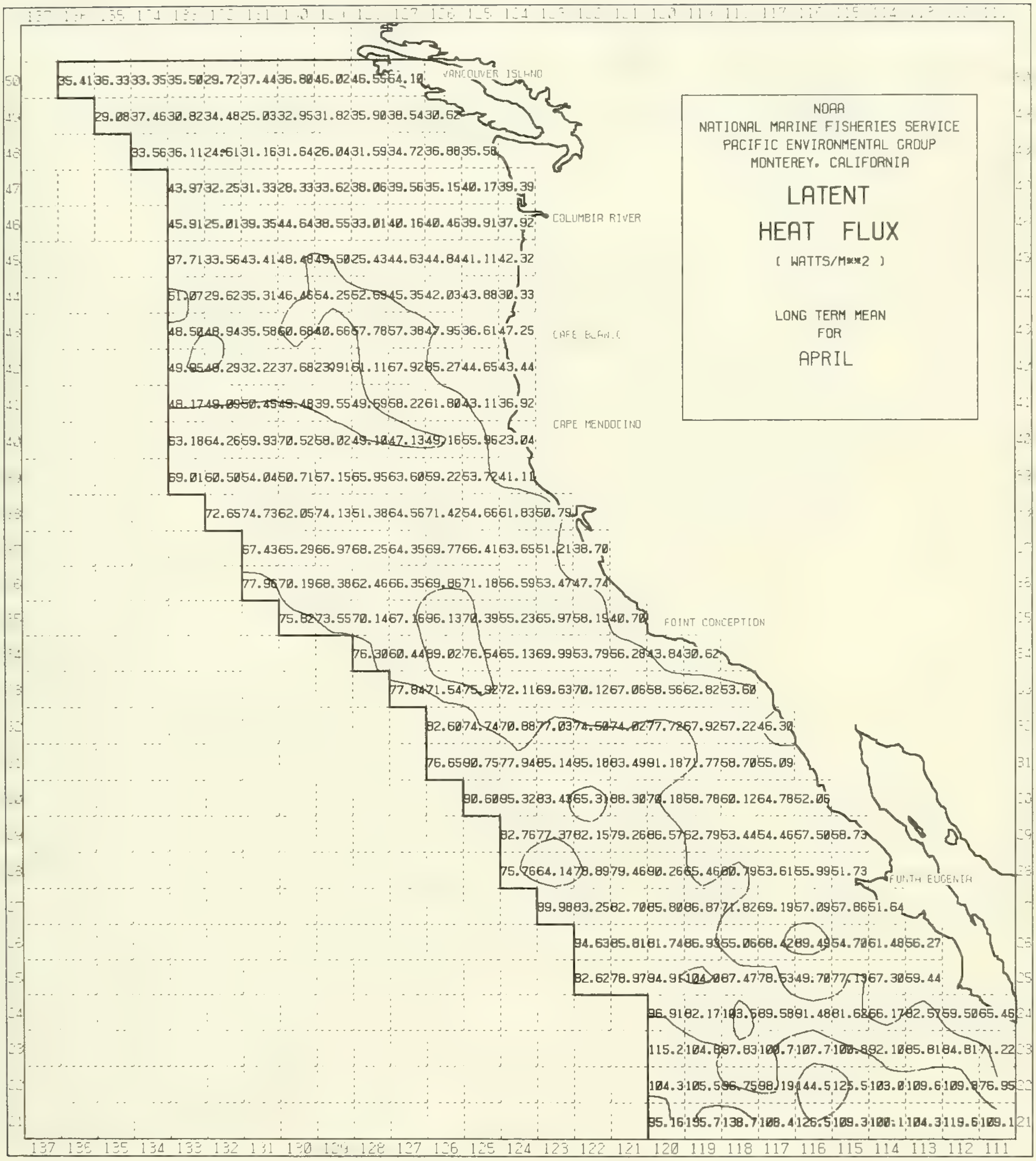

Chart 28.—Composite monthly mean latent heat flux for April.

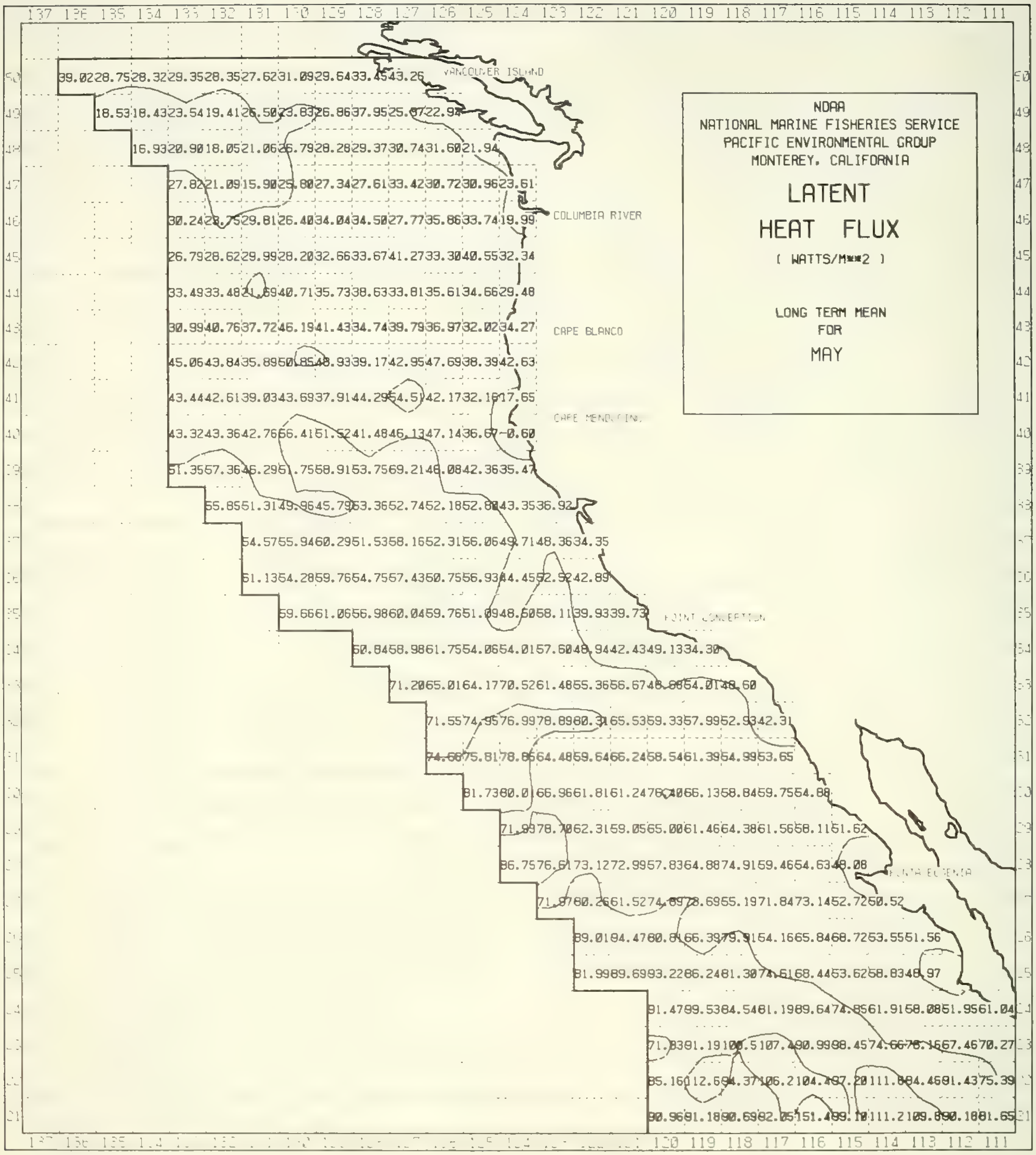

Chart 29.—Composite monthly mean latent heat flux for May.

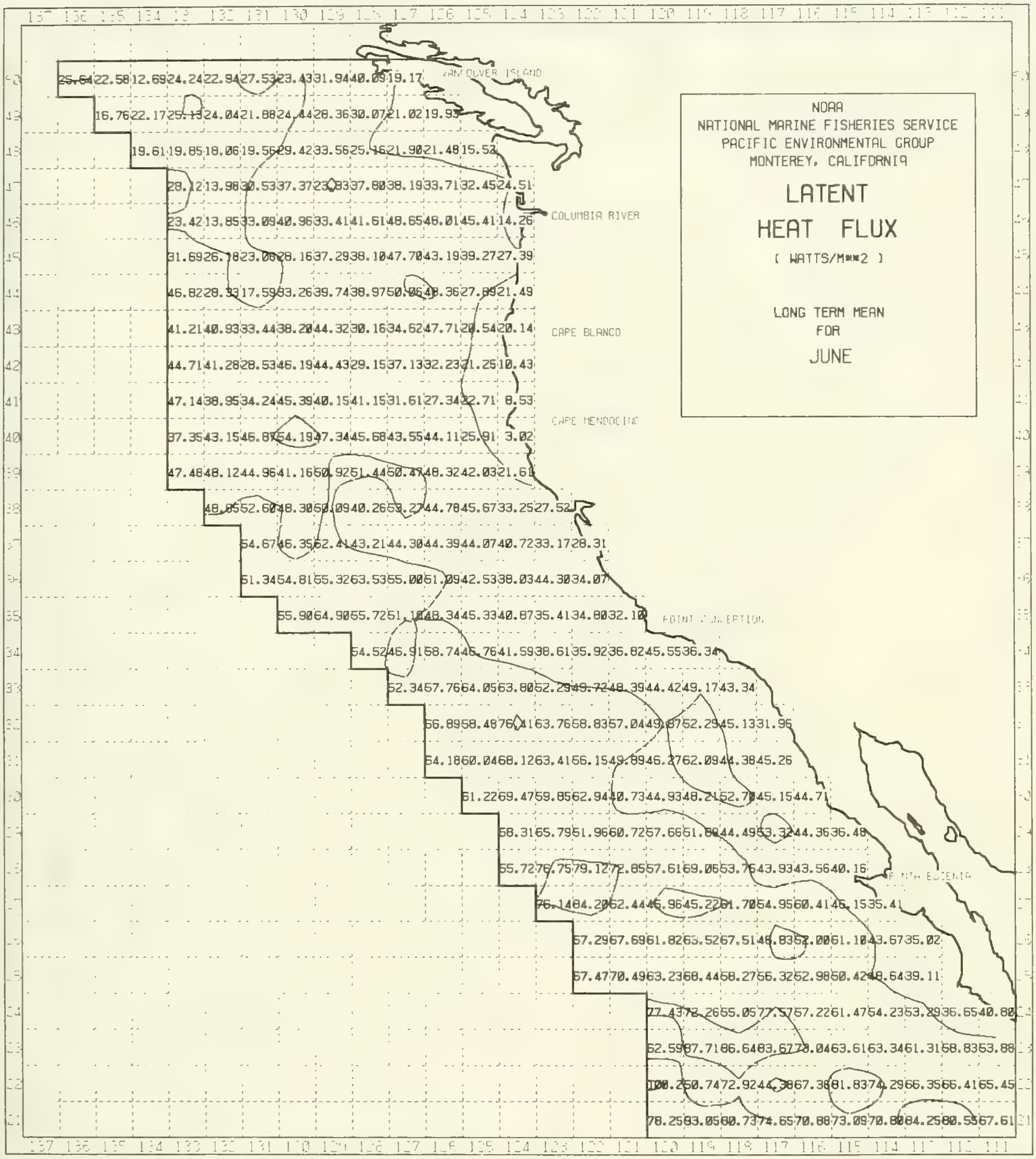

Chart 30.—Composite monthly mean latent heat flux for June.

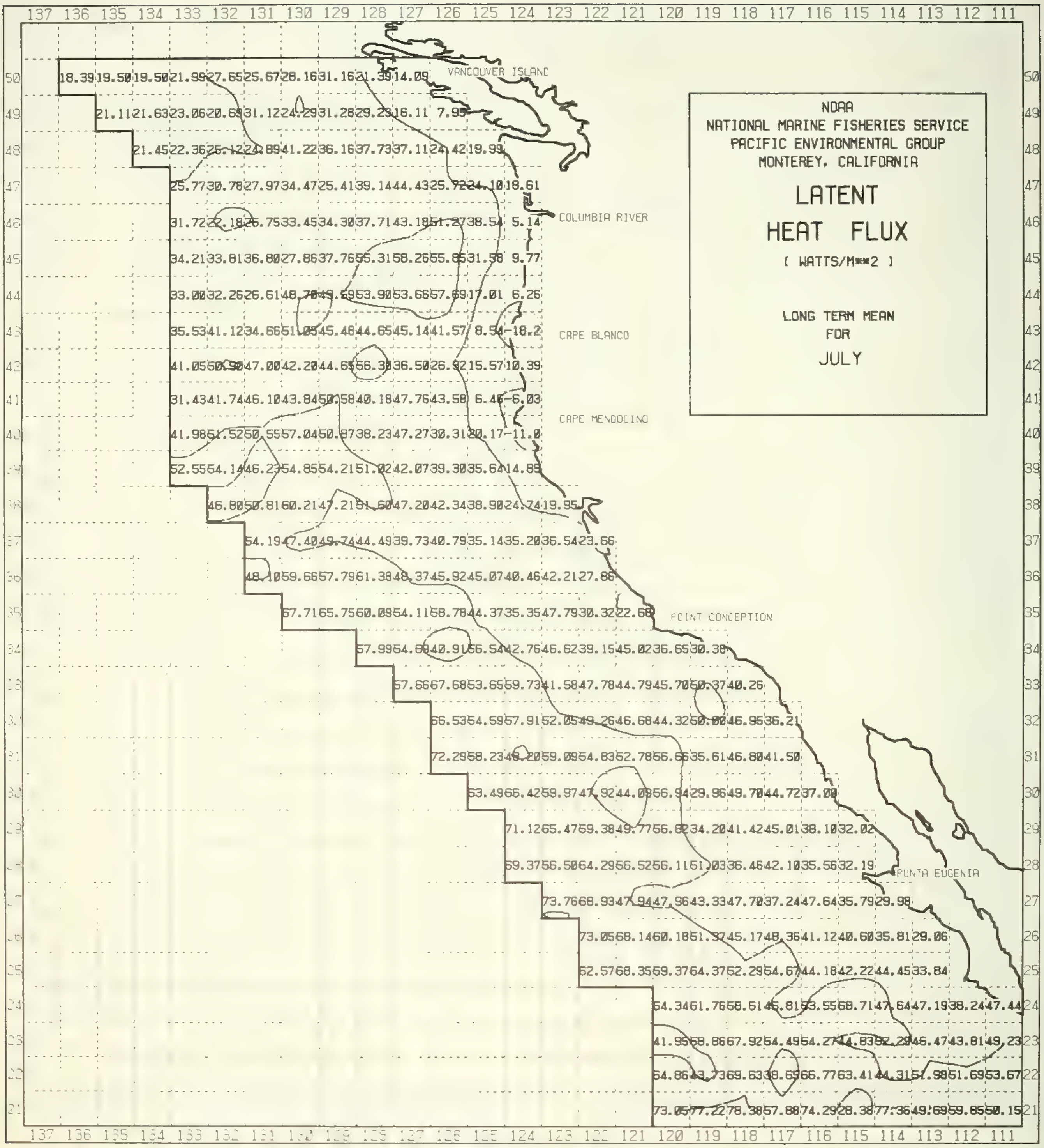

Chart 31.—Composite monthly mean latent heat flux for July.

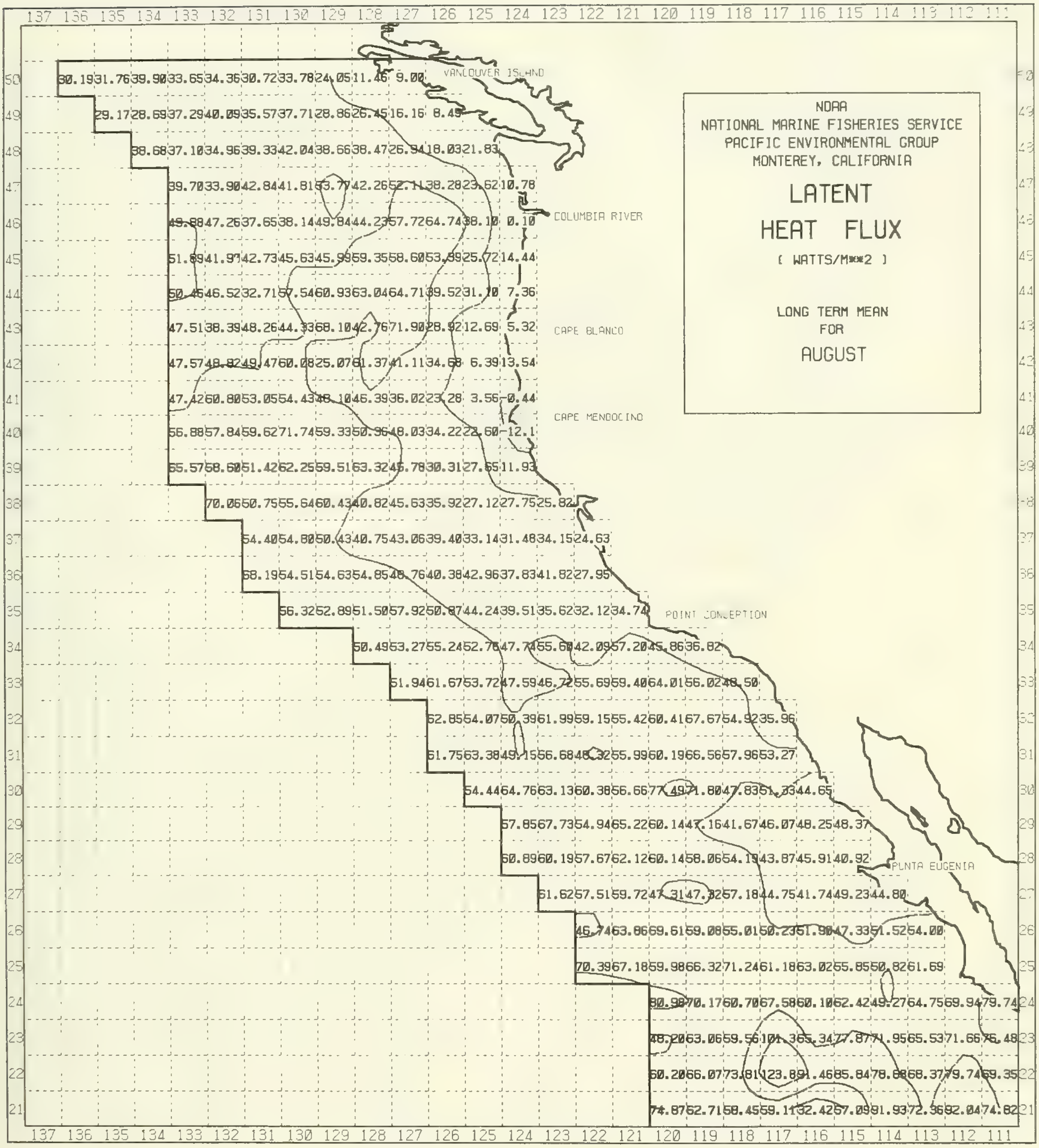

Chart 32.—Composite monthly mean latent heat flux for August.

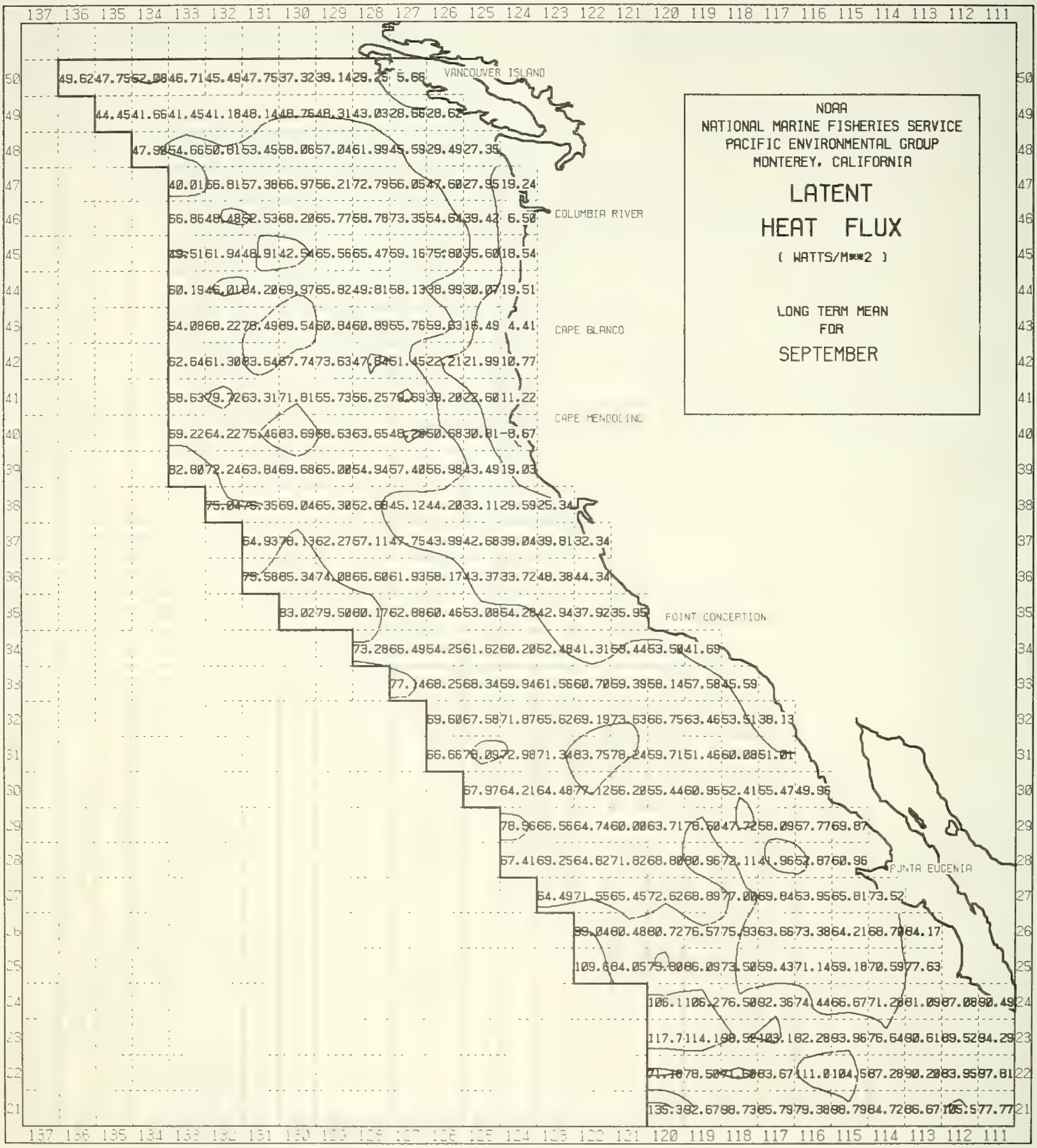

Chart 33.—Composite monthly mean latent heat flux for September.

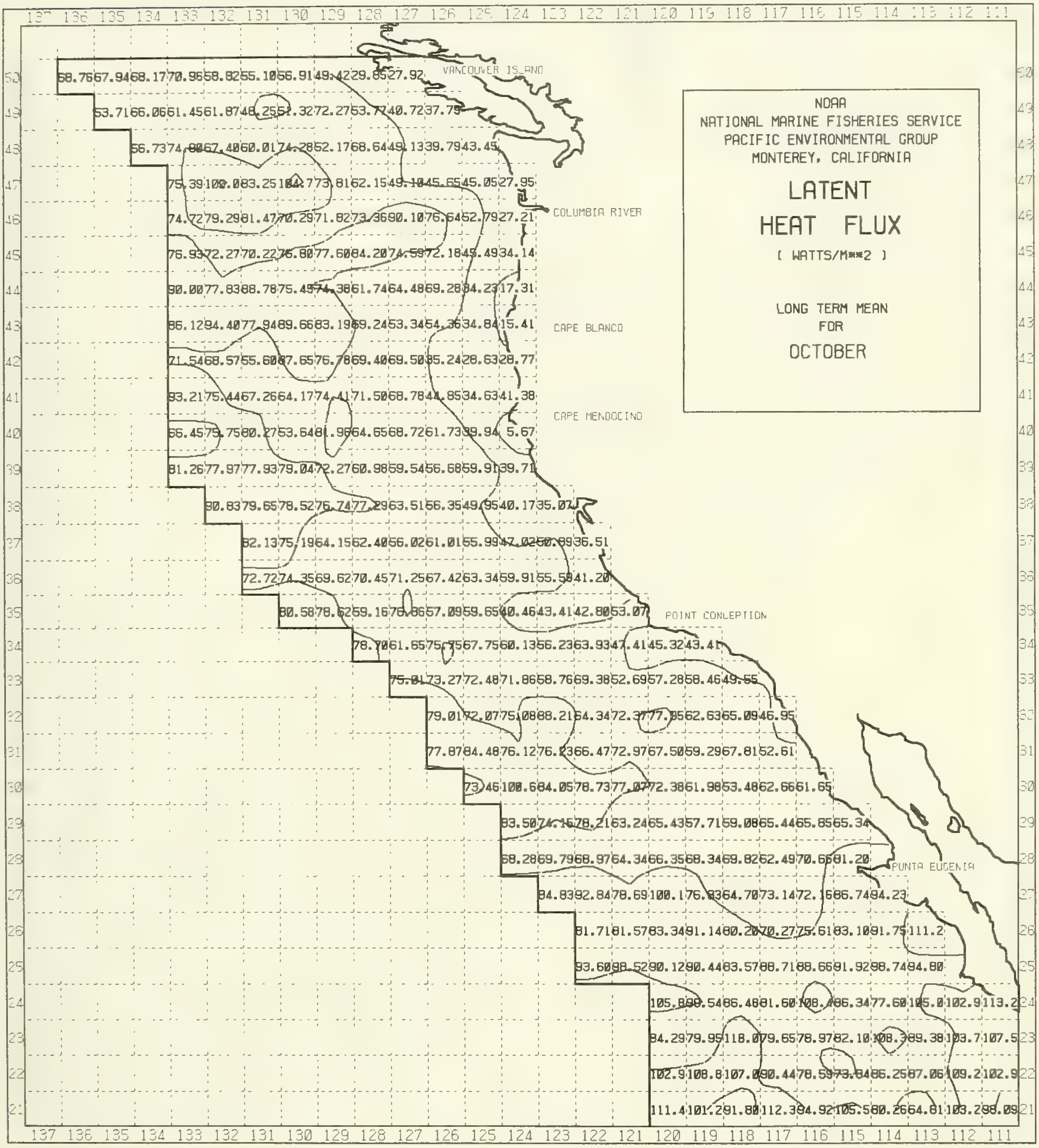

Chart 34.—Composite monthly mean latent heat flux for October.

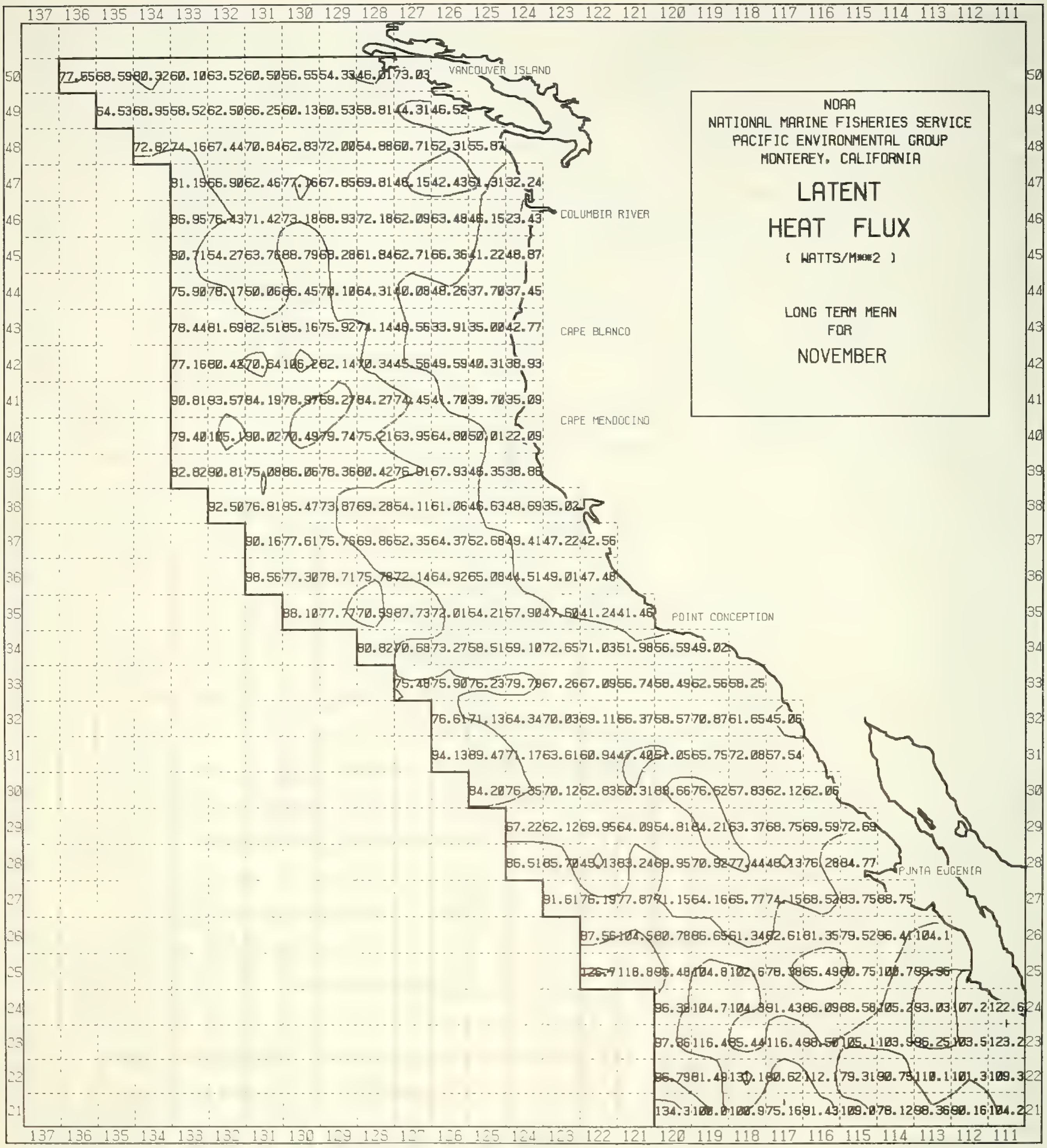

Chart 35.—Composite monthly mean latent heat flux for November.

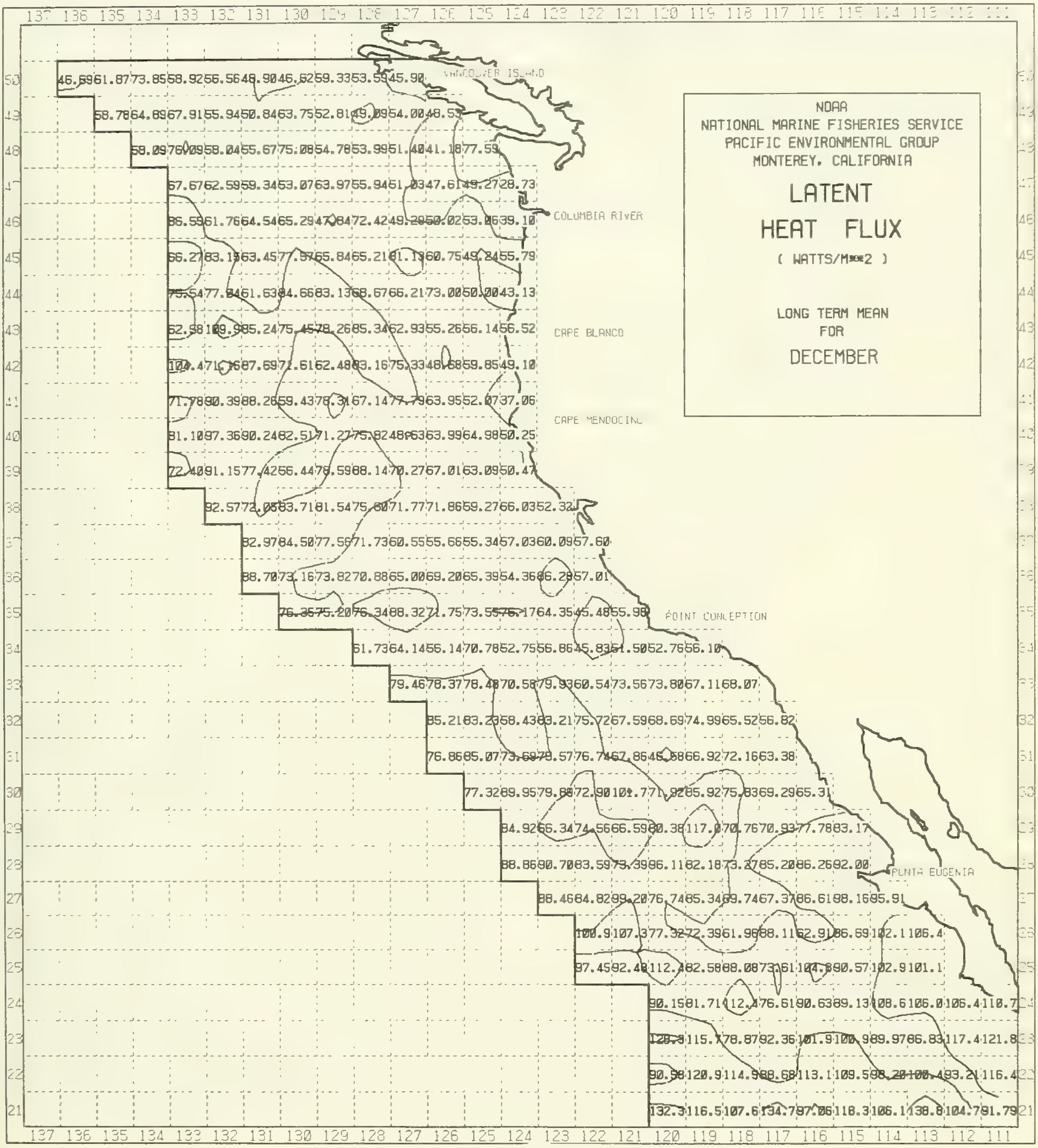

Chart 36.—Composite monthly mean latent heat flux for December.

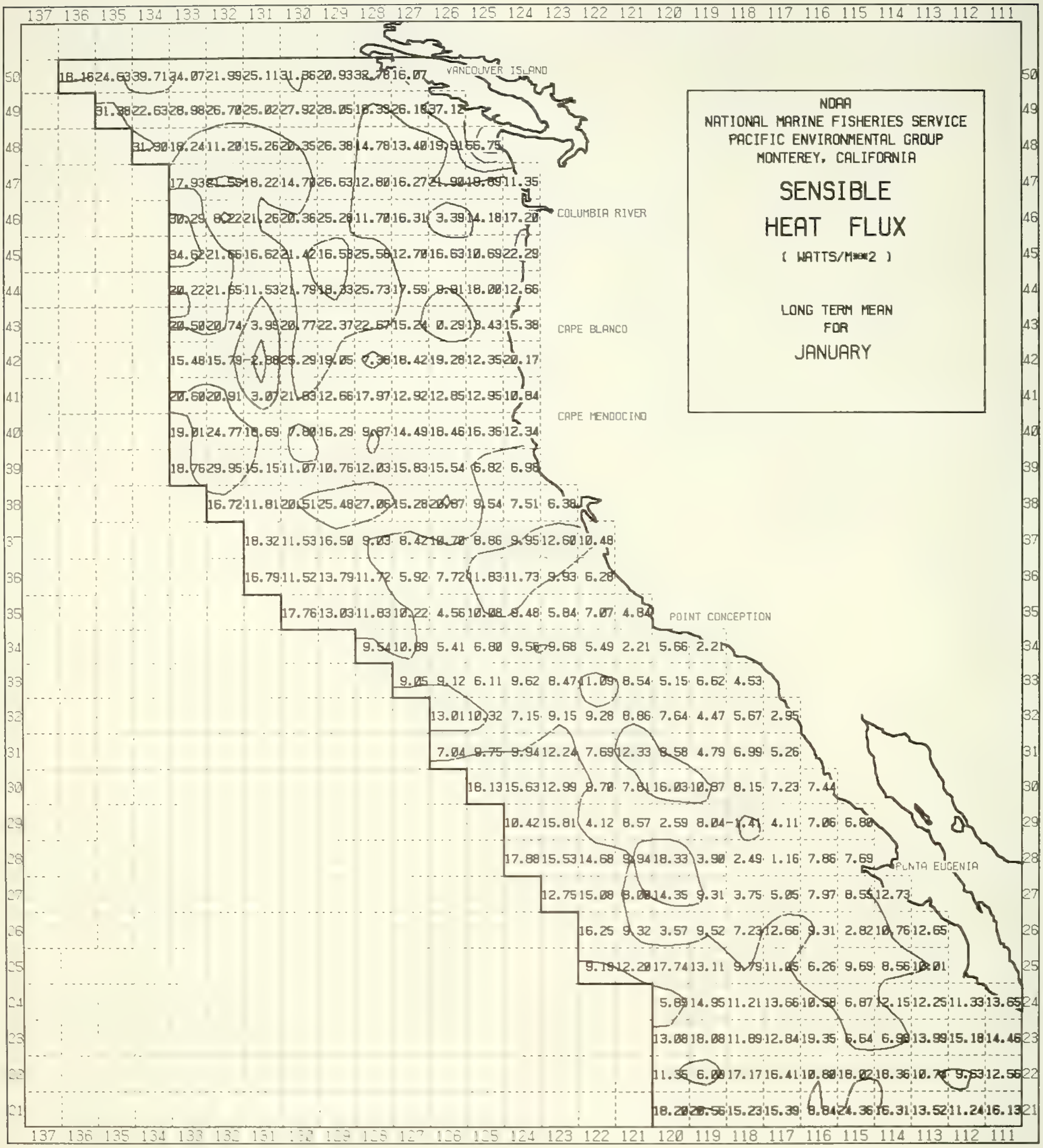

Chart 37.—Composite monthly mean sensible heat flux for January.

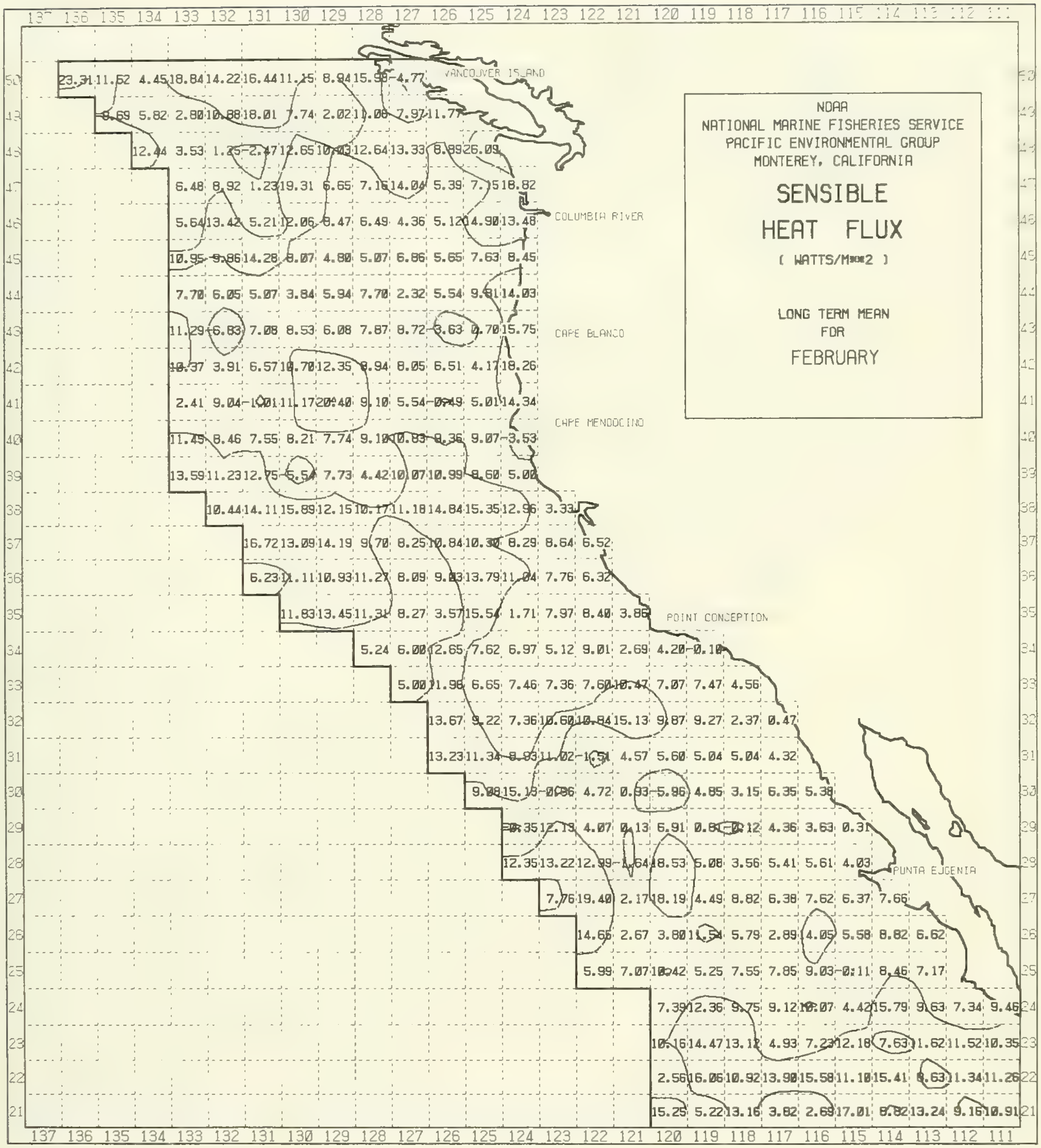

Chart 38.—Composite monthly mean sensible heat flux for February.

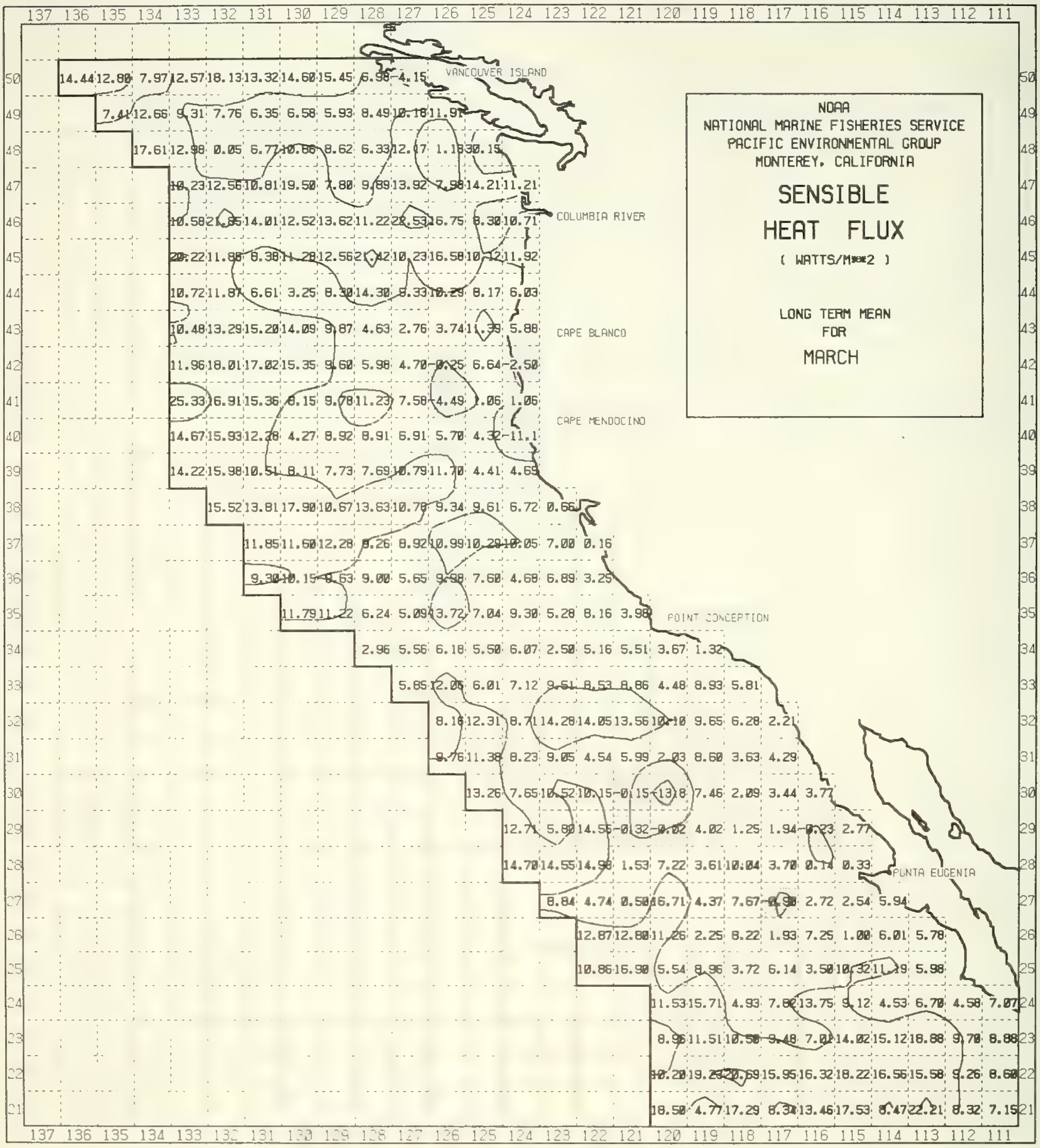

Chart 39.—Composite monthly mean sensible heat flux for March.

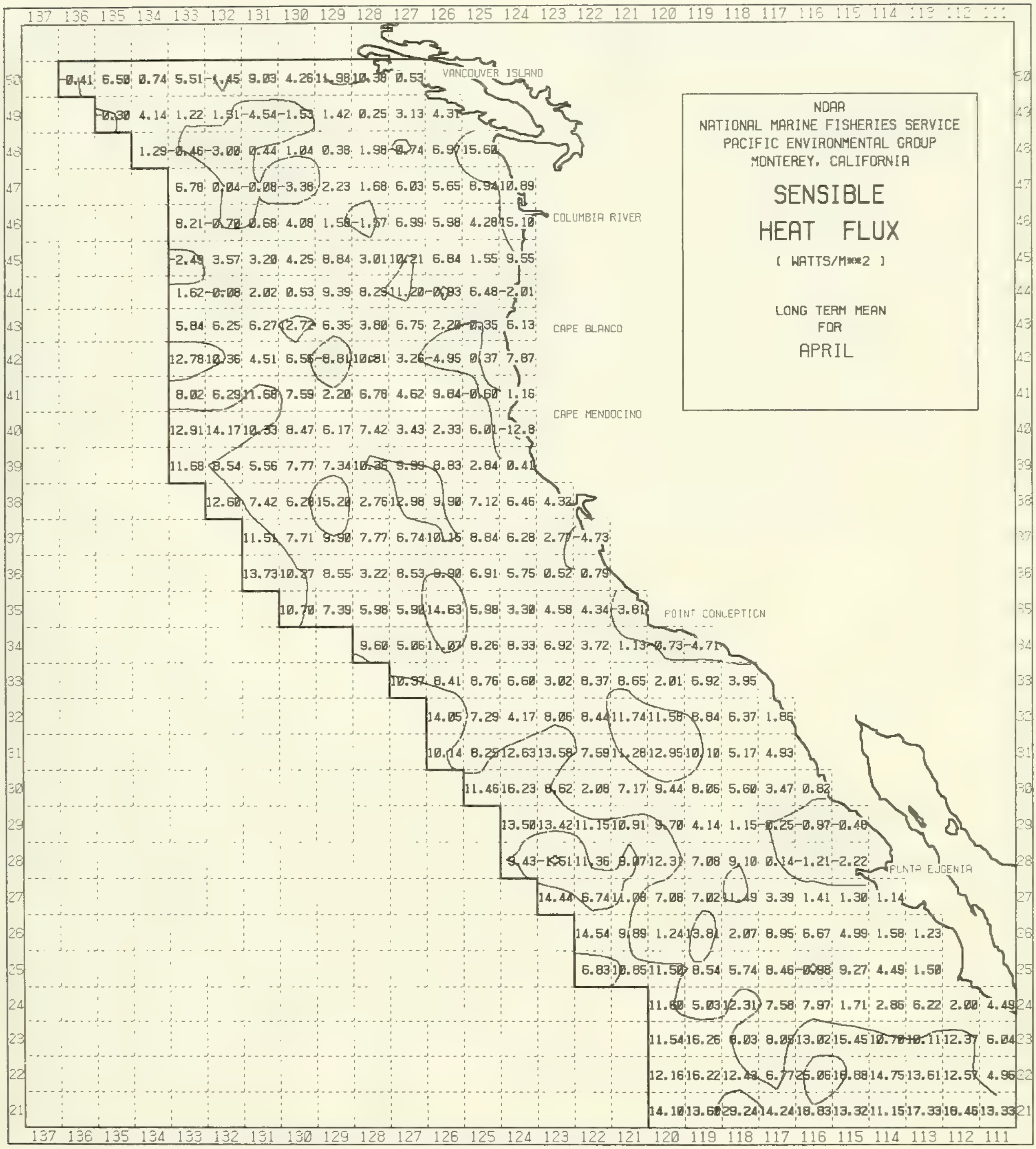

Chart 40.—Composite monthly mean sensible heat flux for April.

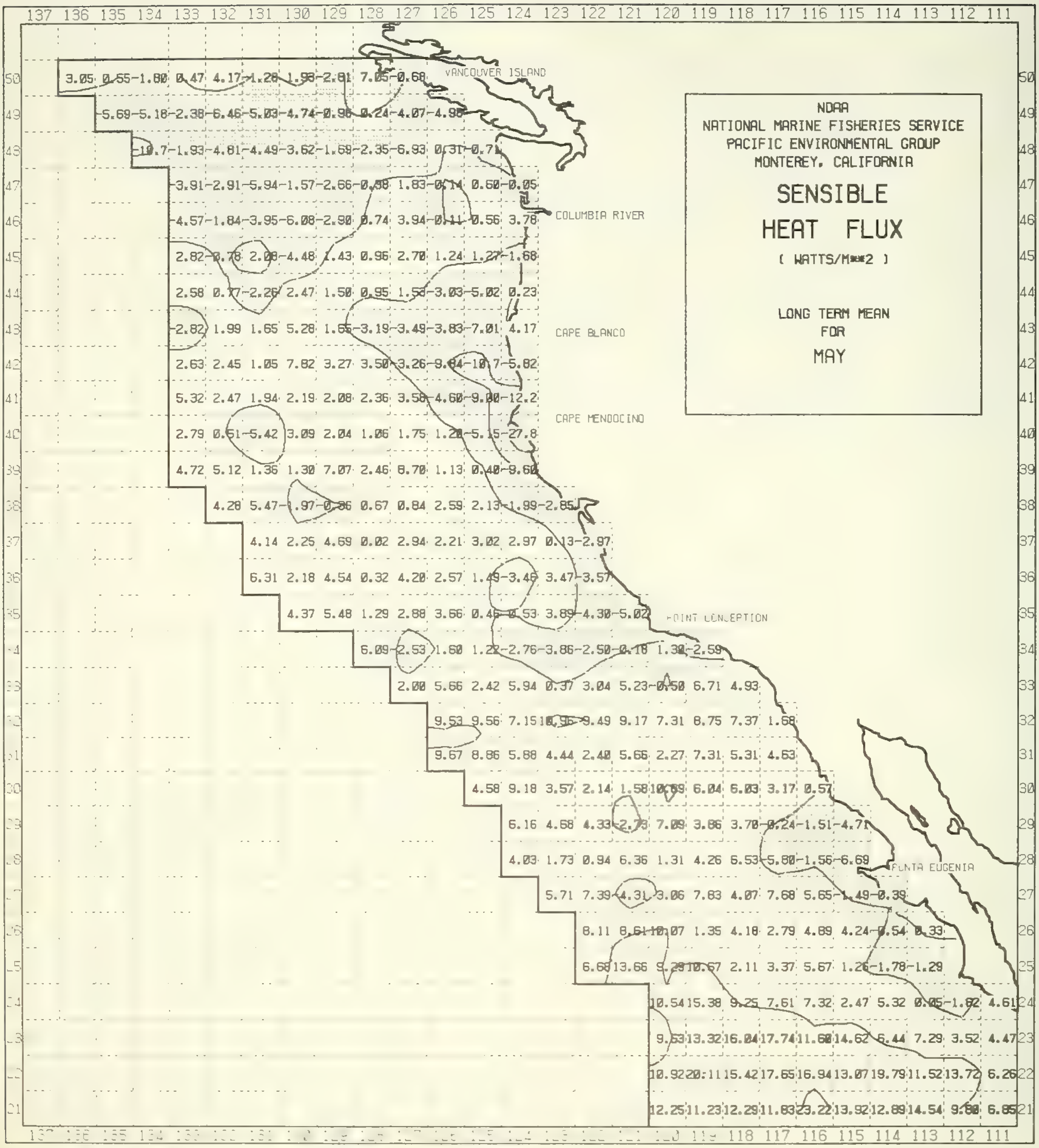

Chart 41.—Composite monthly mean sensible heat flux for May.

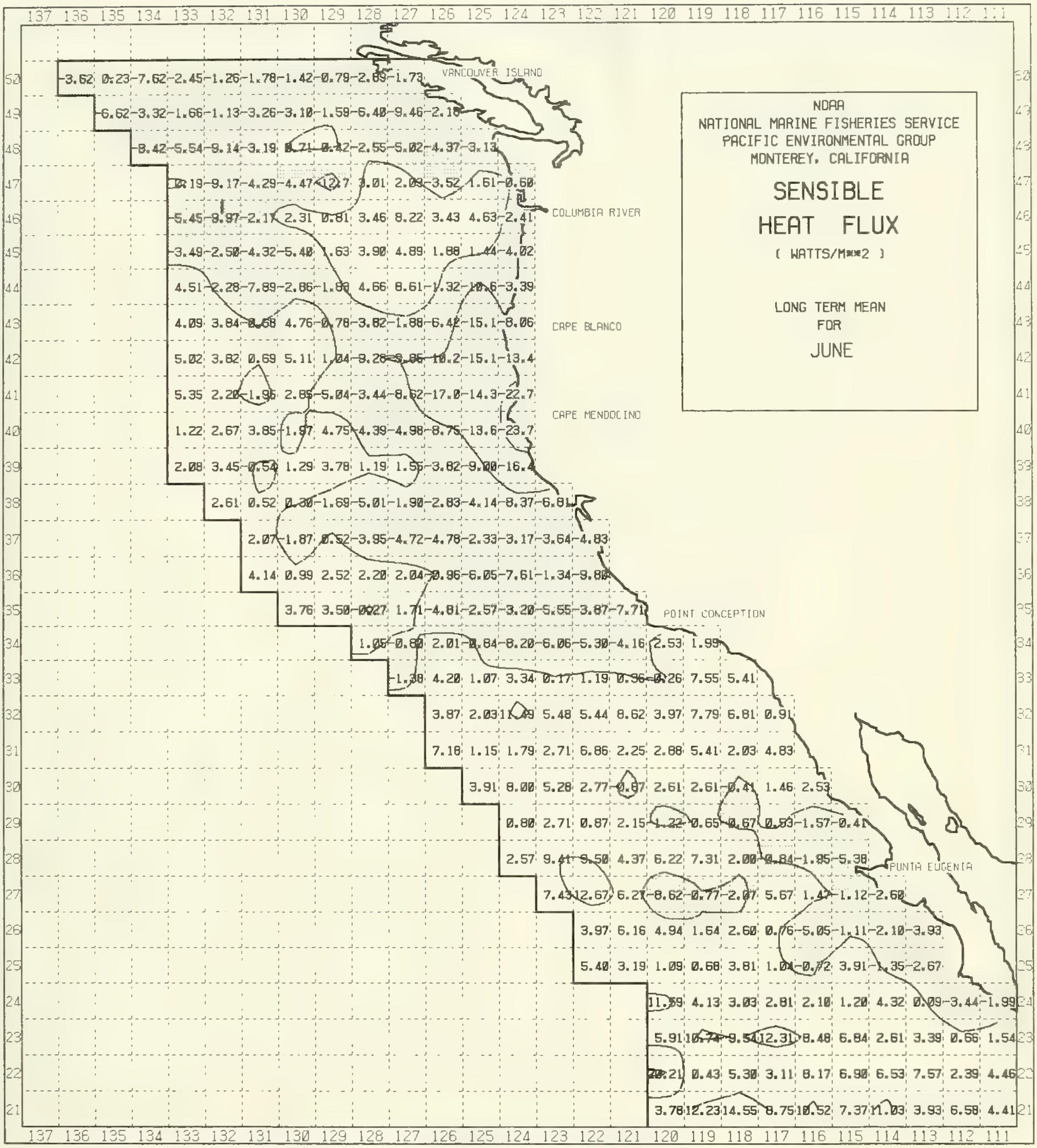

Chart 42.—Composite monthly mean sensible heat flux for June.

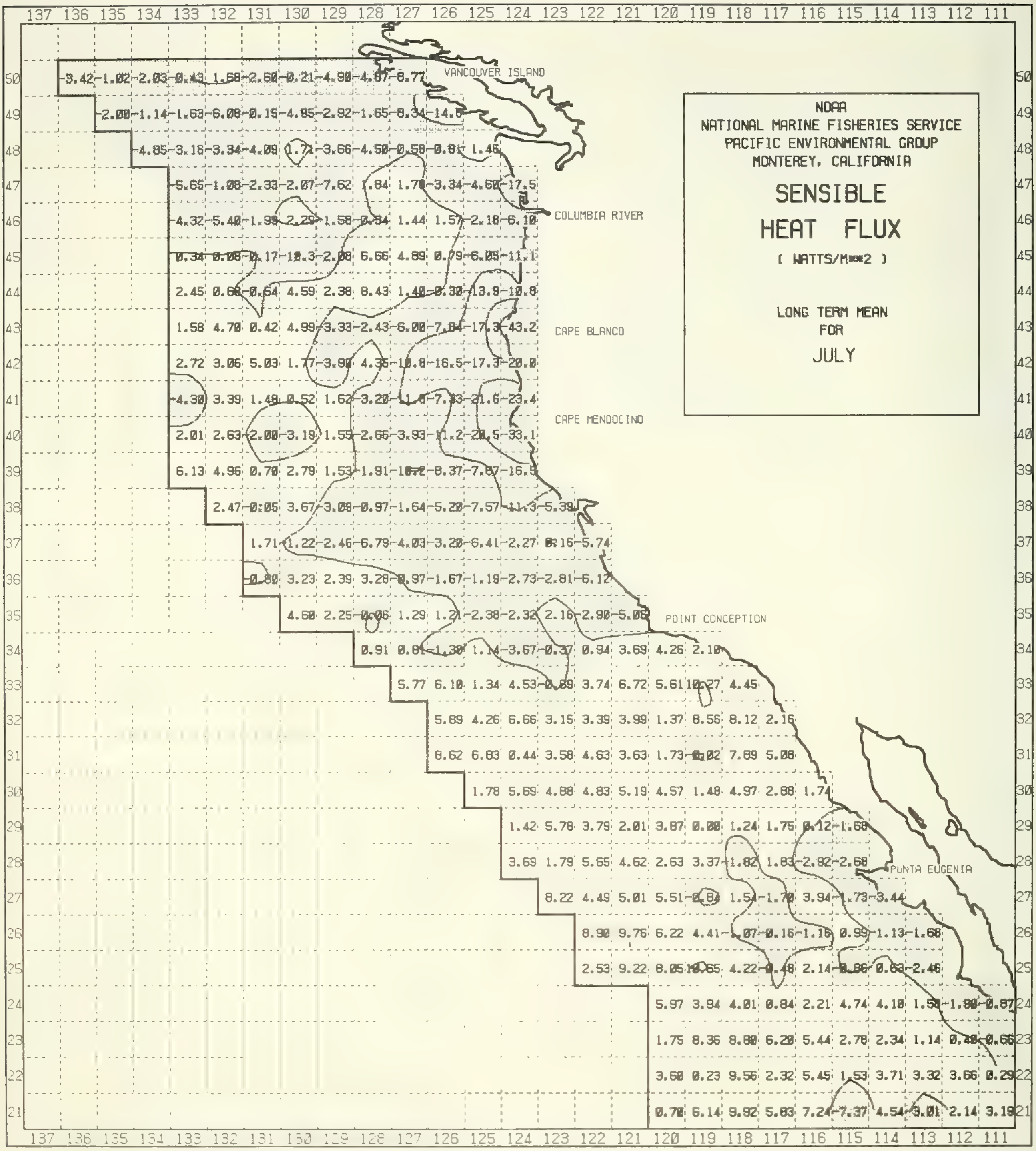

Chart 43.—Composite monthly mean sensible heat flux for July.

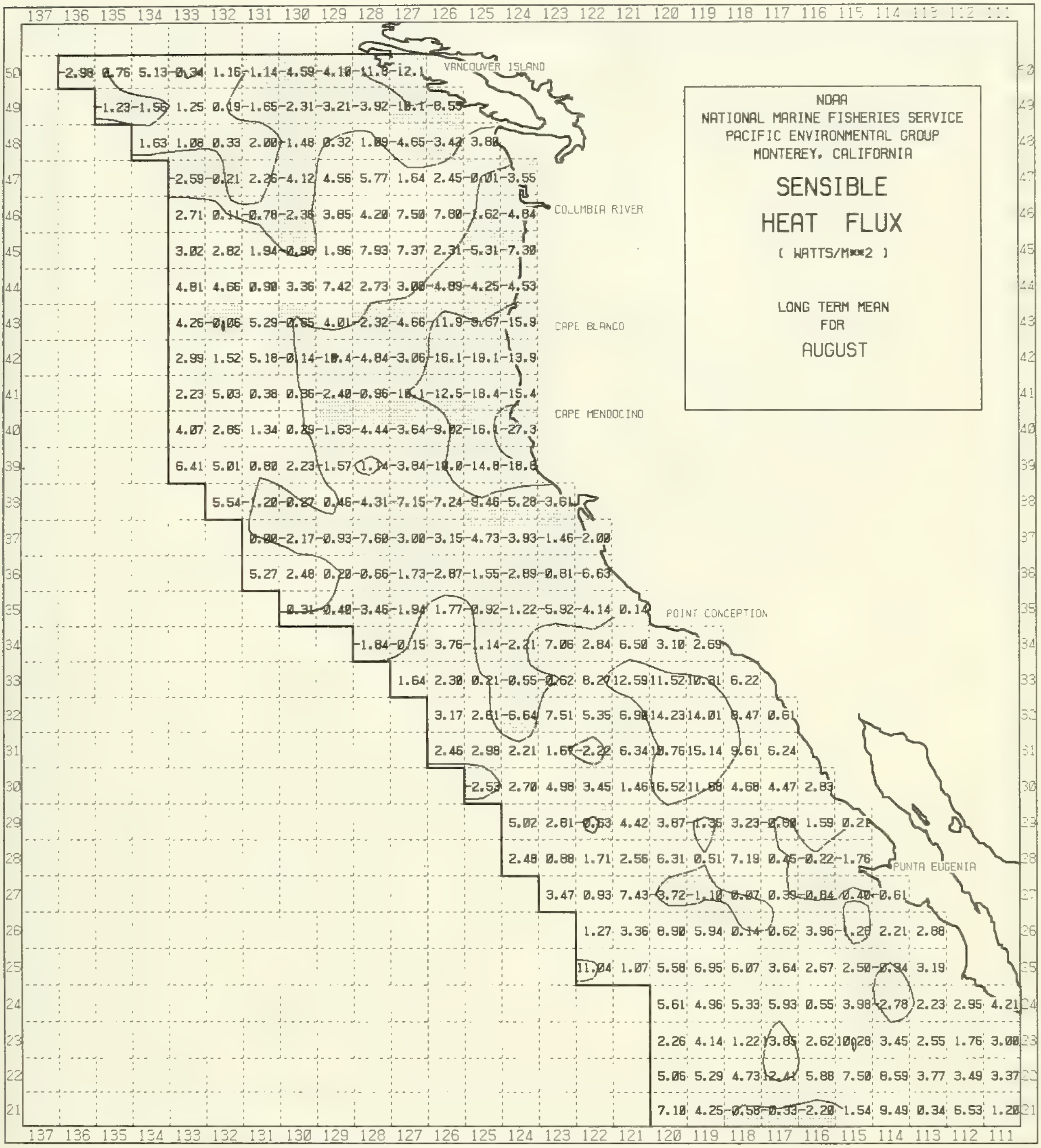

Chart 44.—Composite monthly mean sensible heat flux for August.

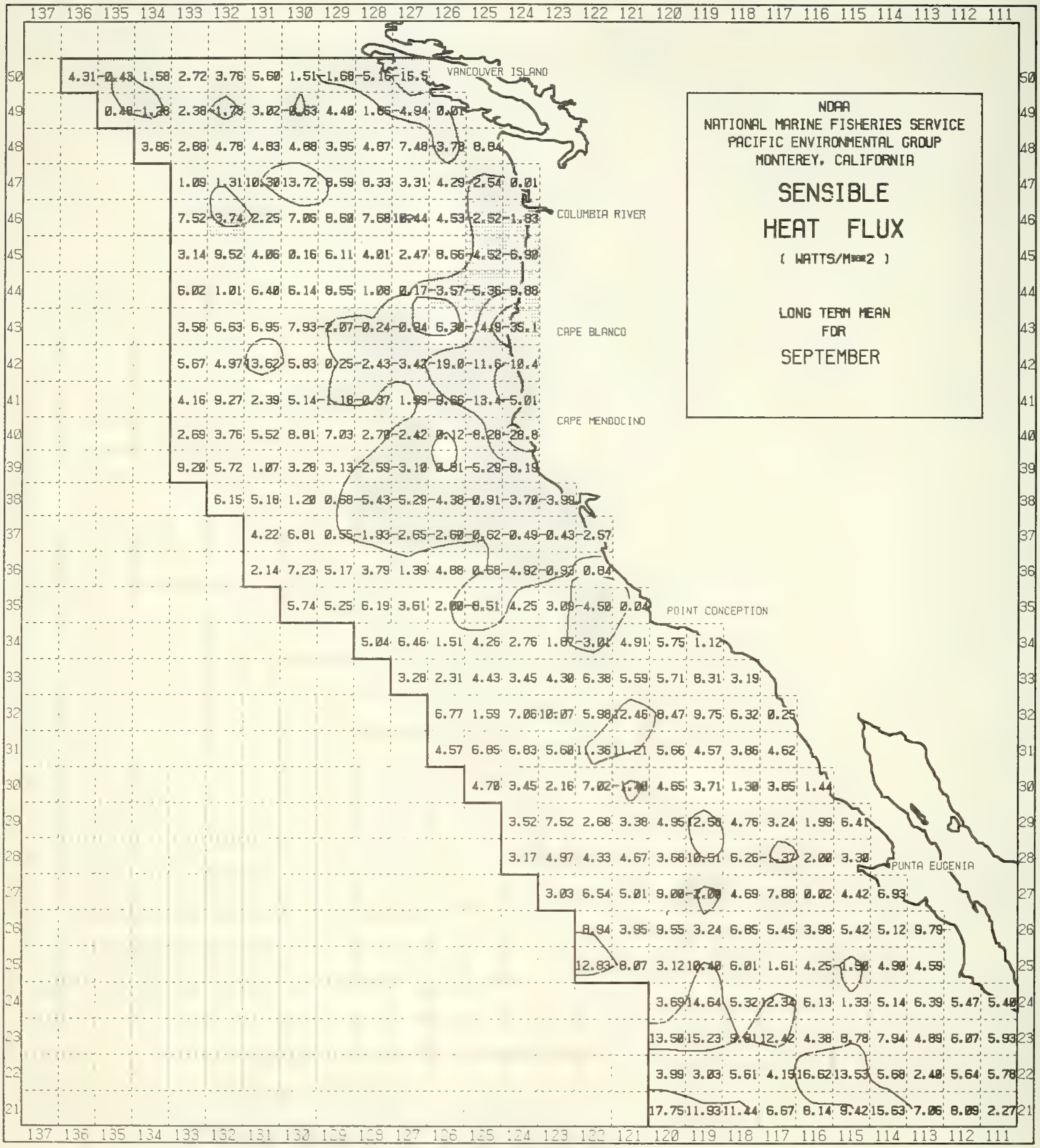

Chart 45.—Composite monthly mean sensible heat flux for September.

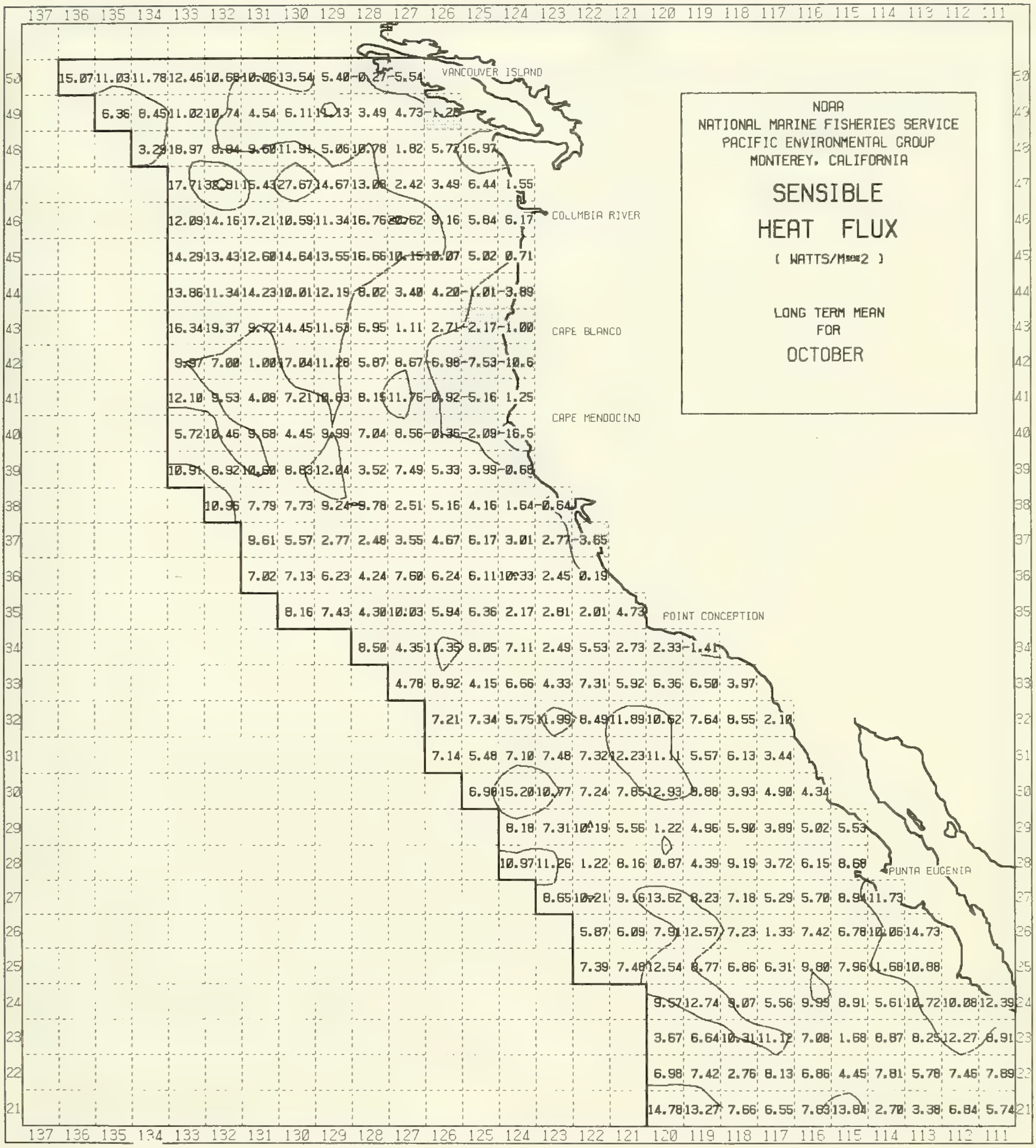

Chart 46.—Composite monthly mean sensible heat flux for October.

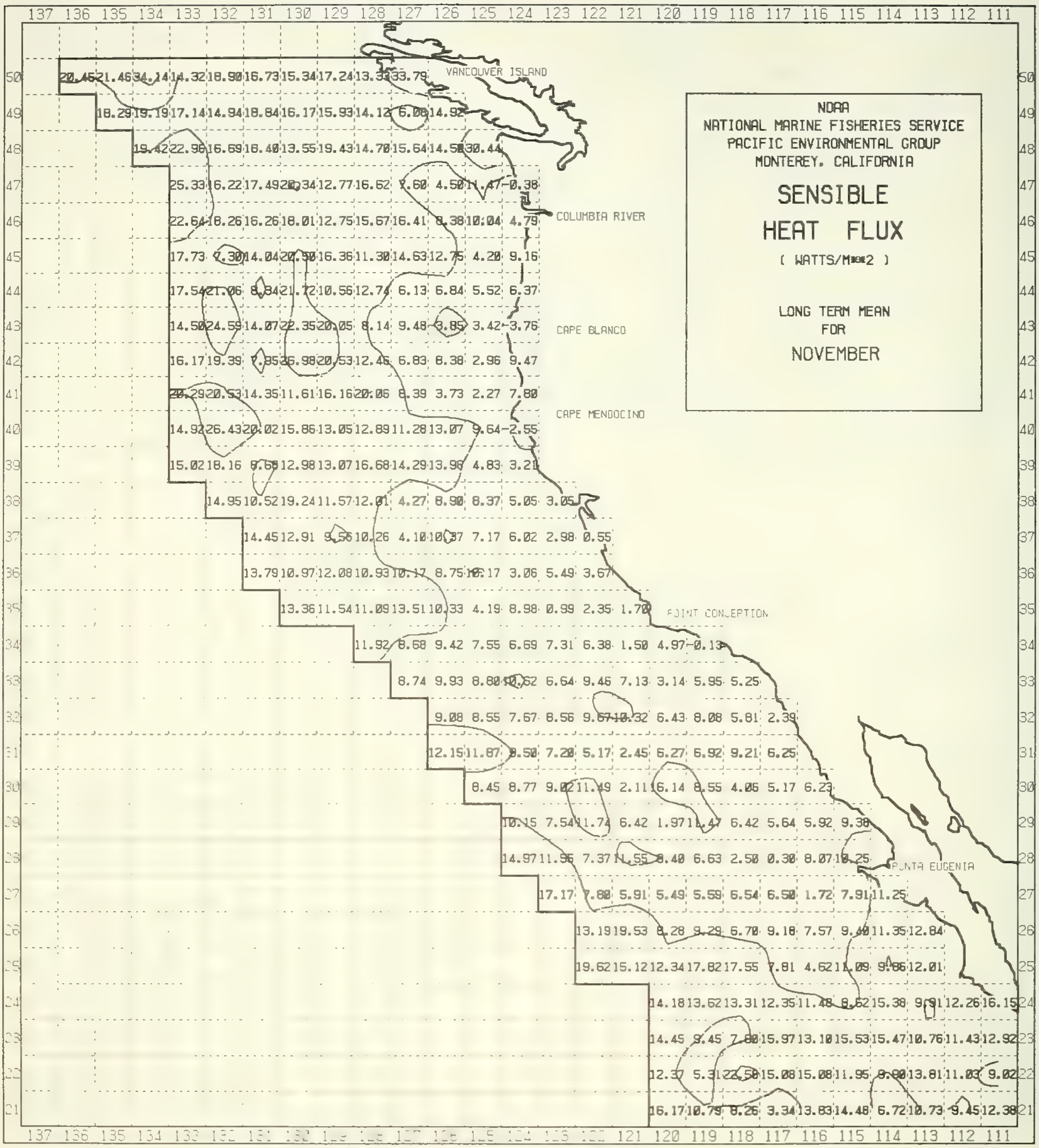

Chart 47.—Composite monthly mean sensible heat flux for November.

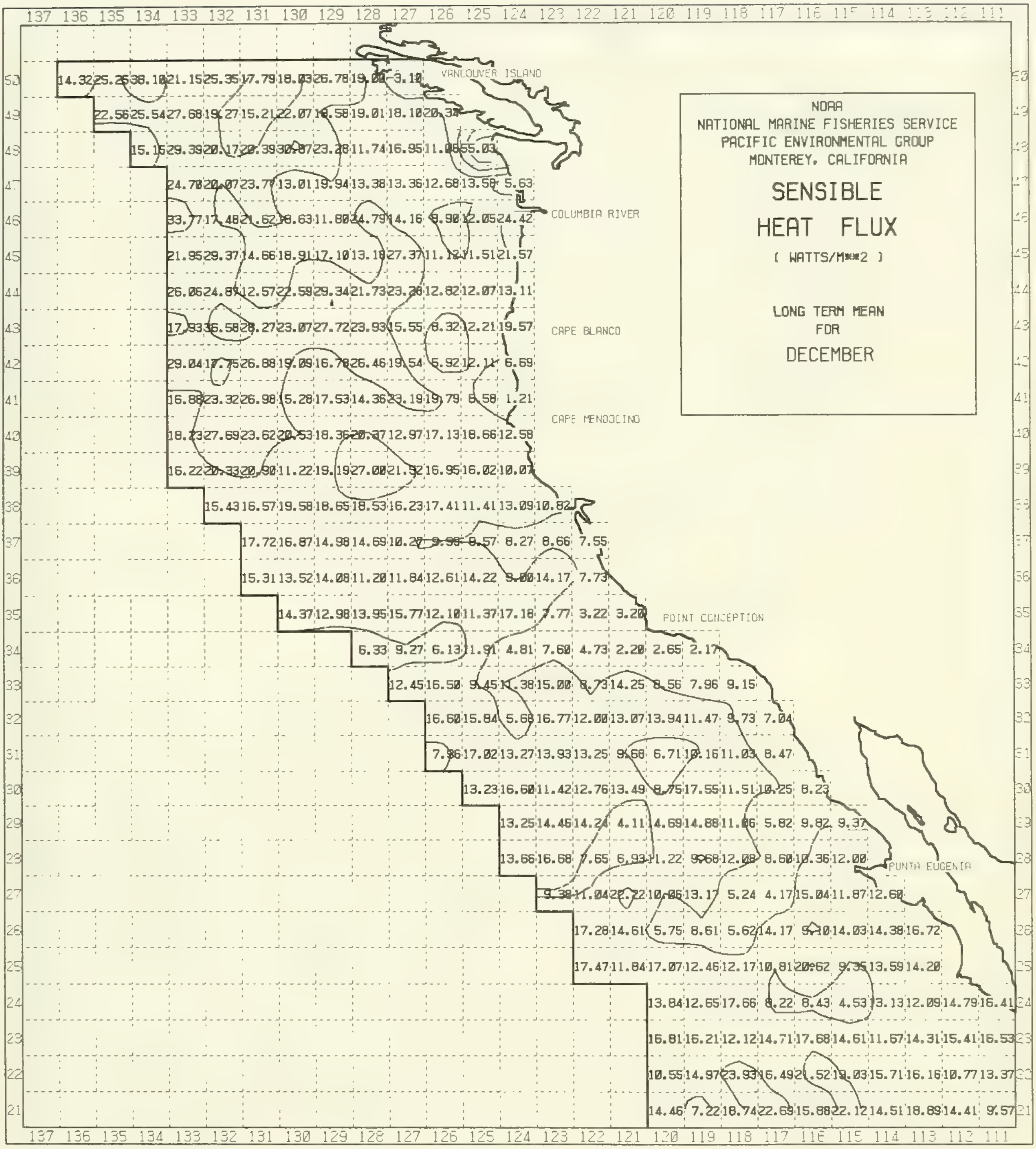

Chart 48.—Composite monthly mean sensible heat flux for December.

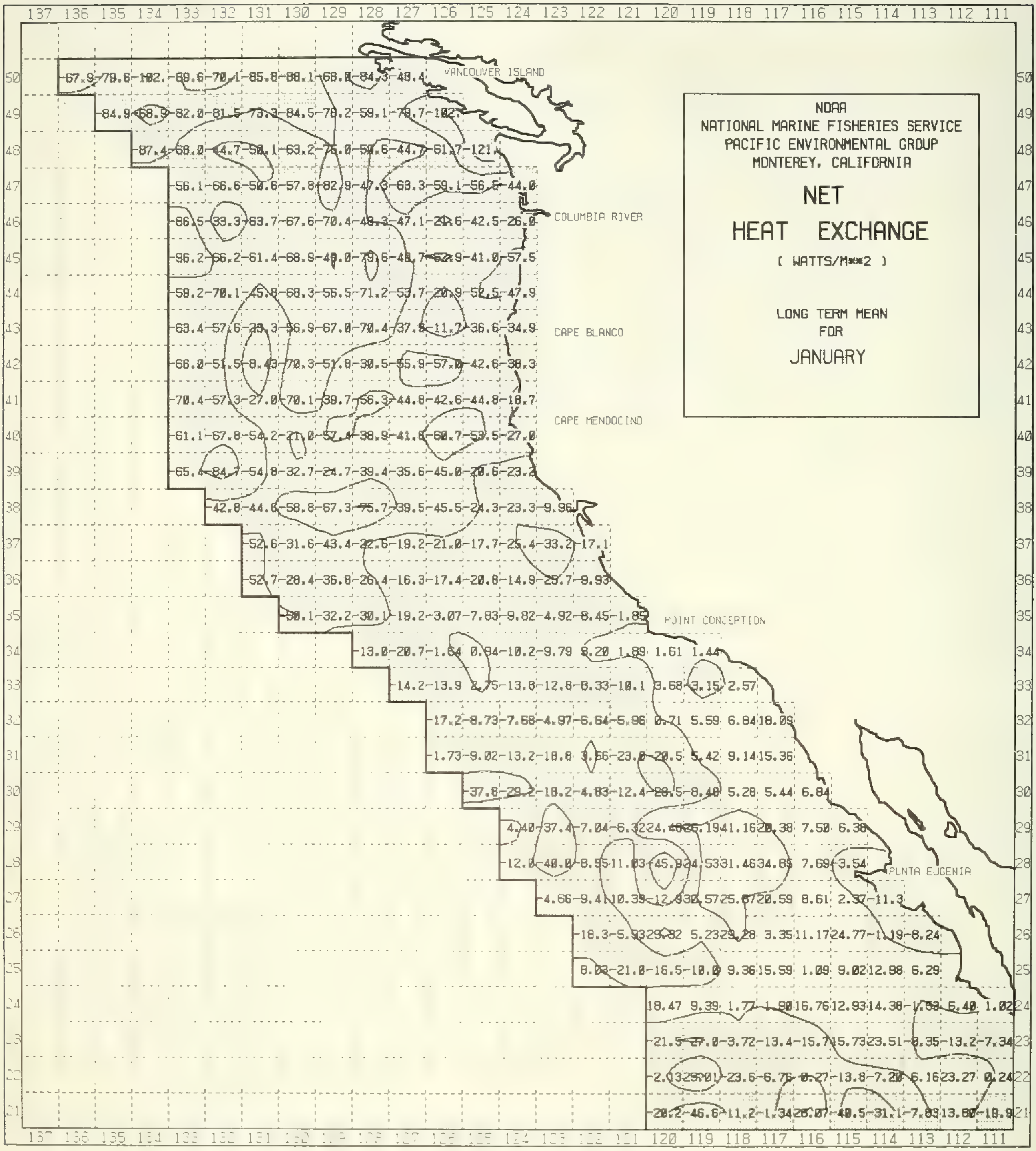

Chart 49.—Composite monthly mean net heat exchange for January.

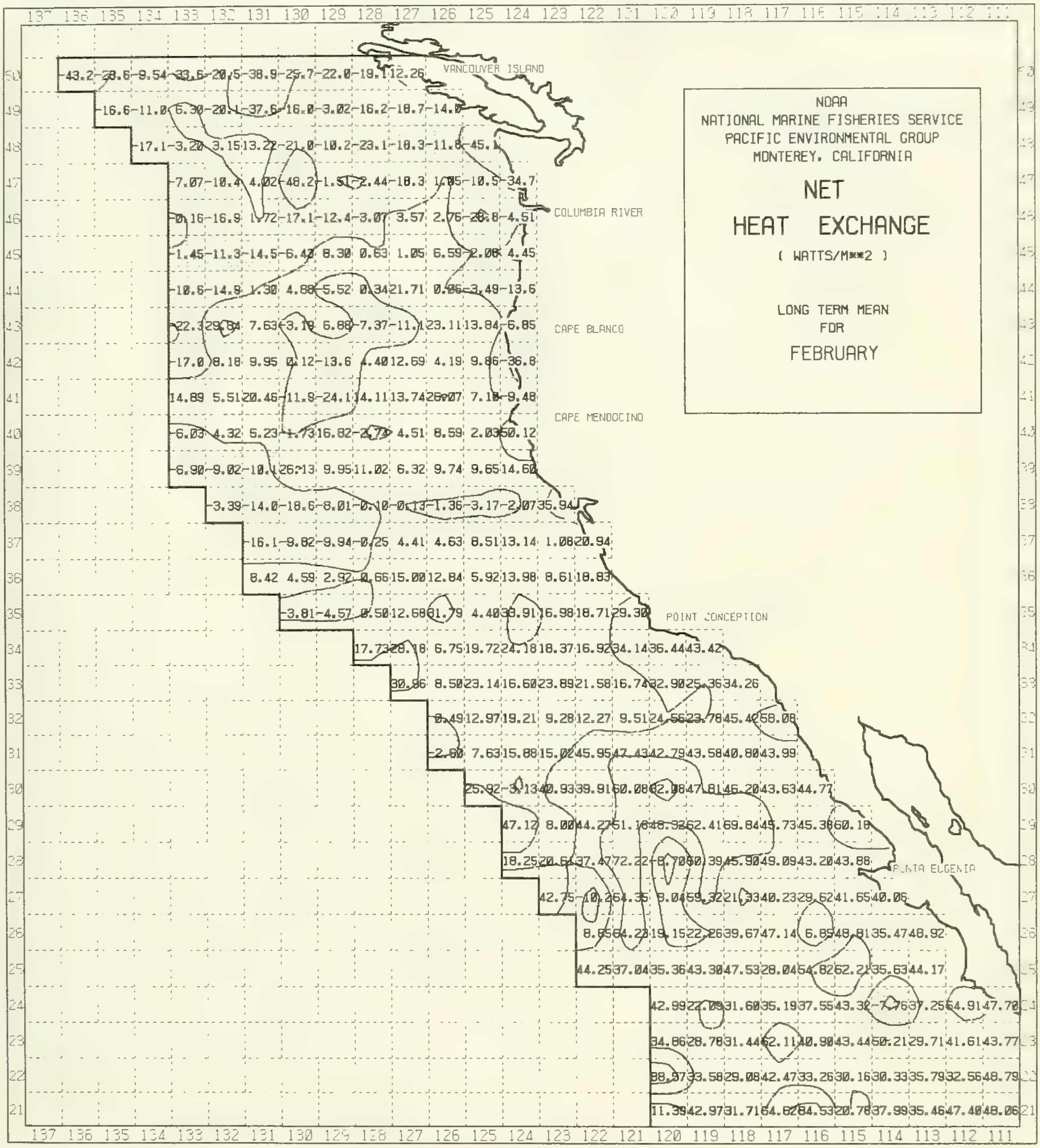

Chart 50.—Composite monthly mean net heat exchange for February.

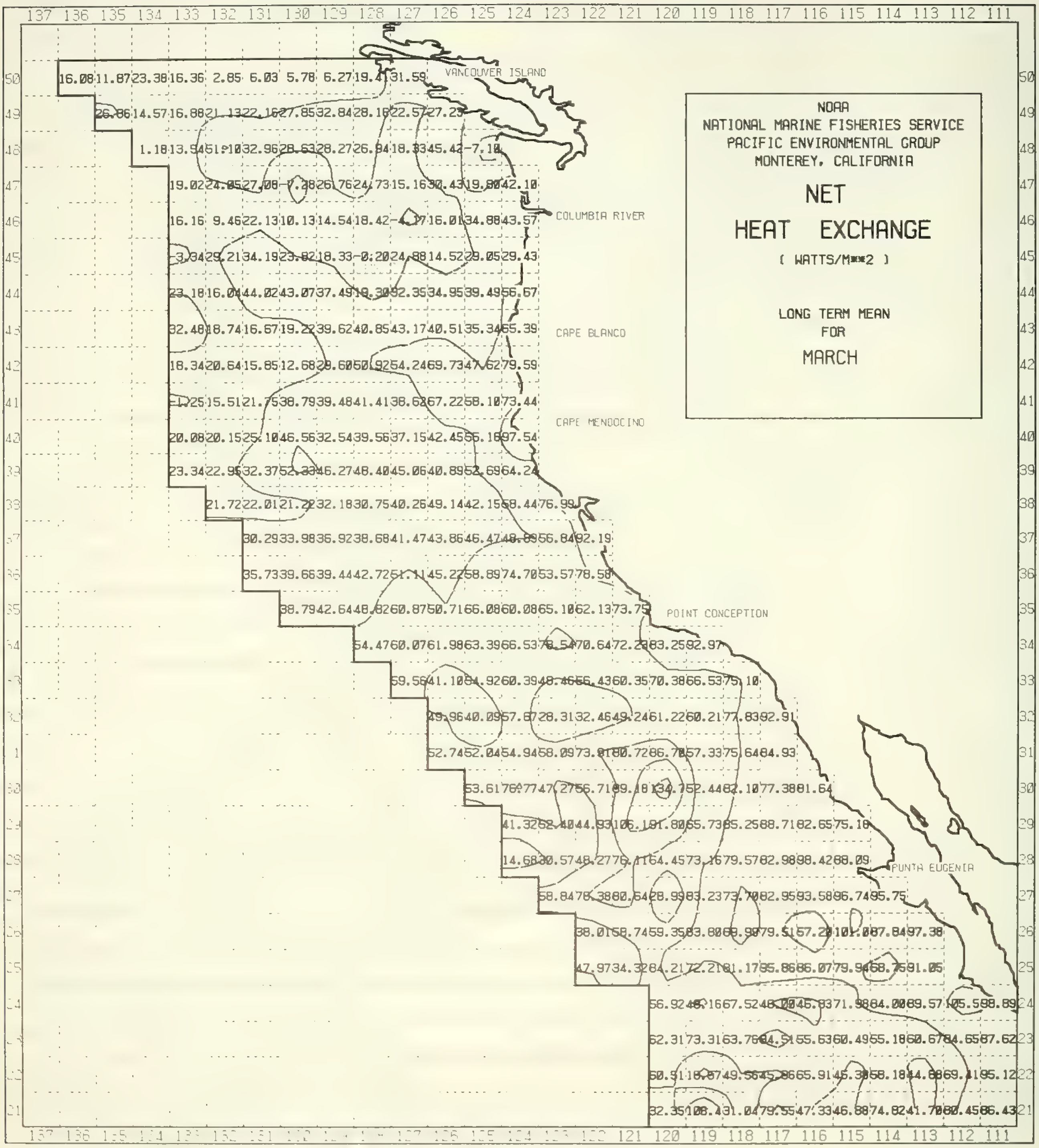

Chart 51.—Composite monthly mean net heat exchange for March.

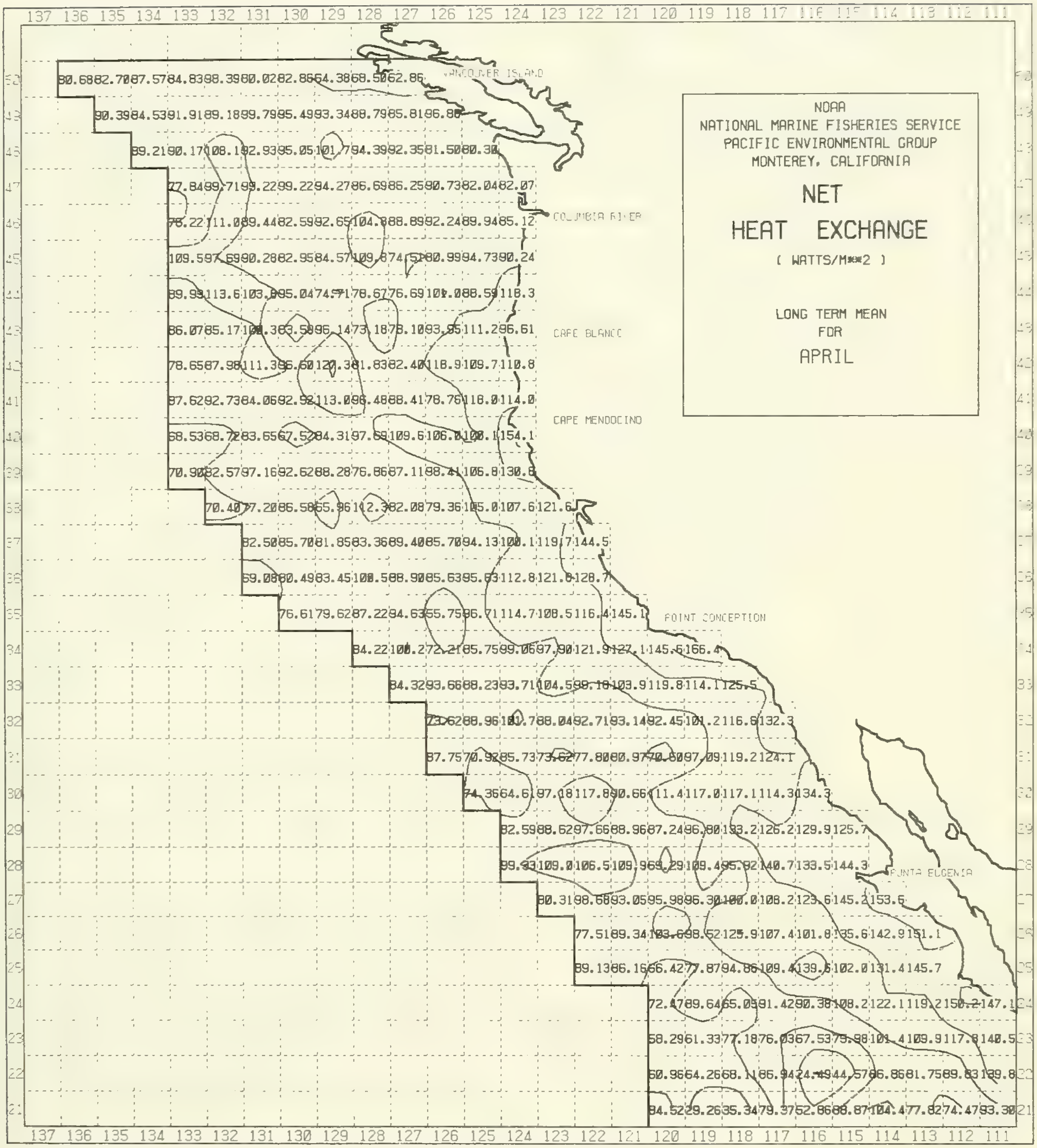

Chart 52.—Composite monthly mean net heat exchange for April.

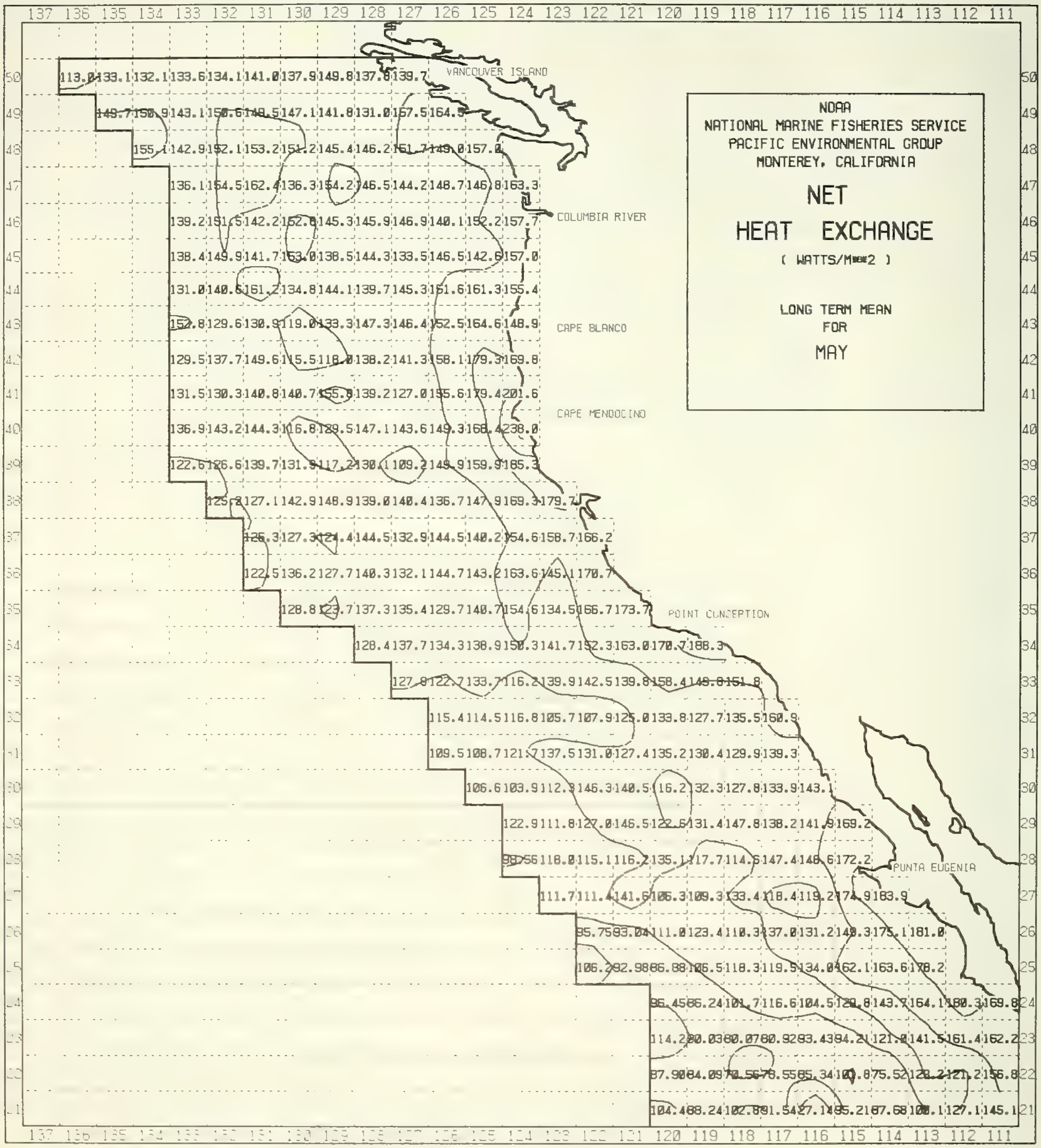

Chart 53.—Composite monthly mean net heat exchange for May.

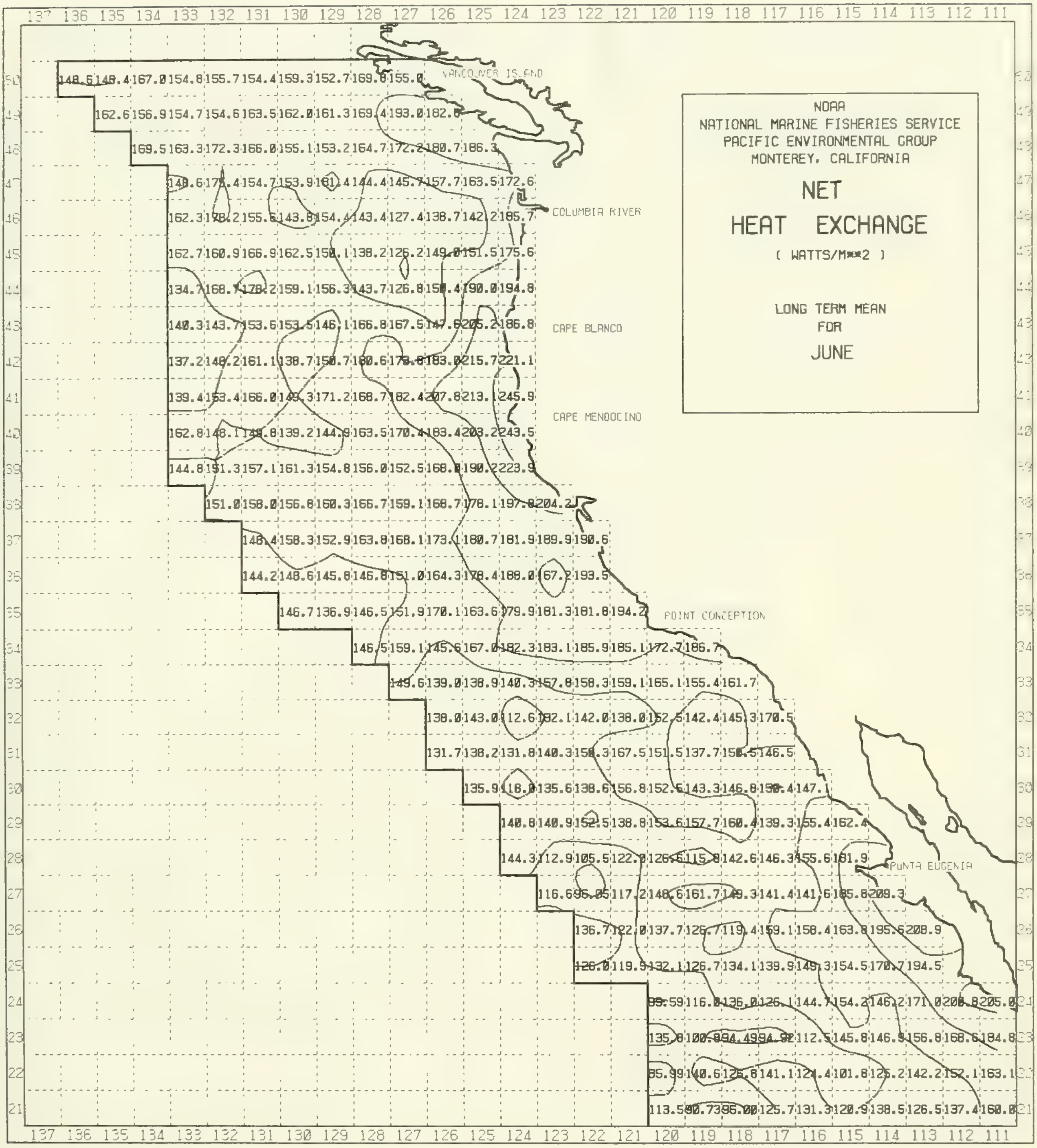

Chart 54.—Composite monthly mean net heat exchange for June.

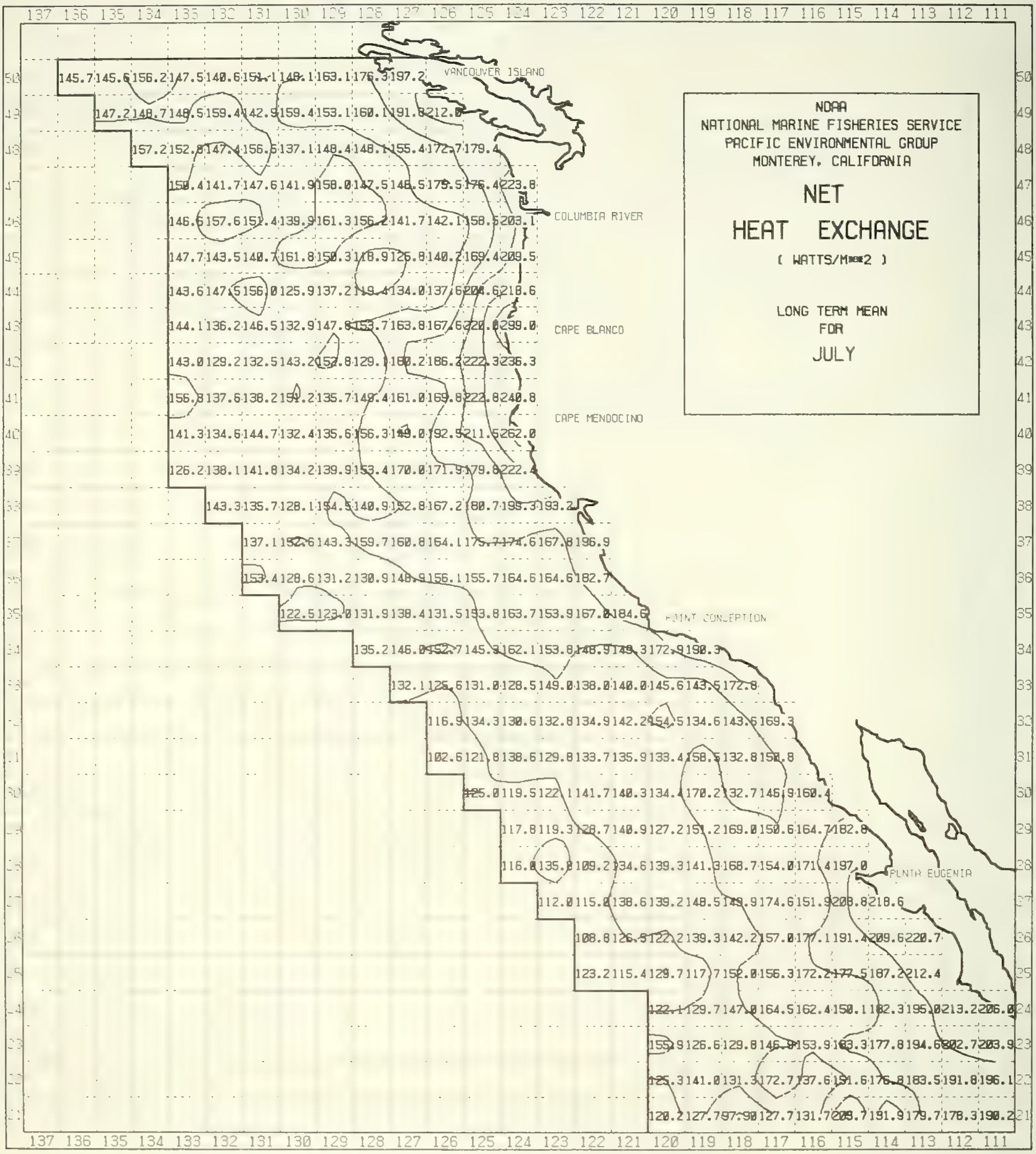

Chart 55.—Composite monthly mean net heat exchange for July.

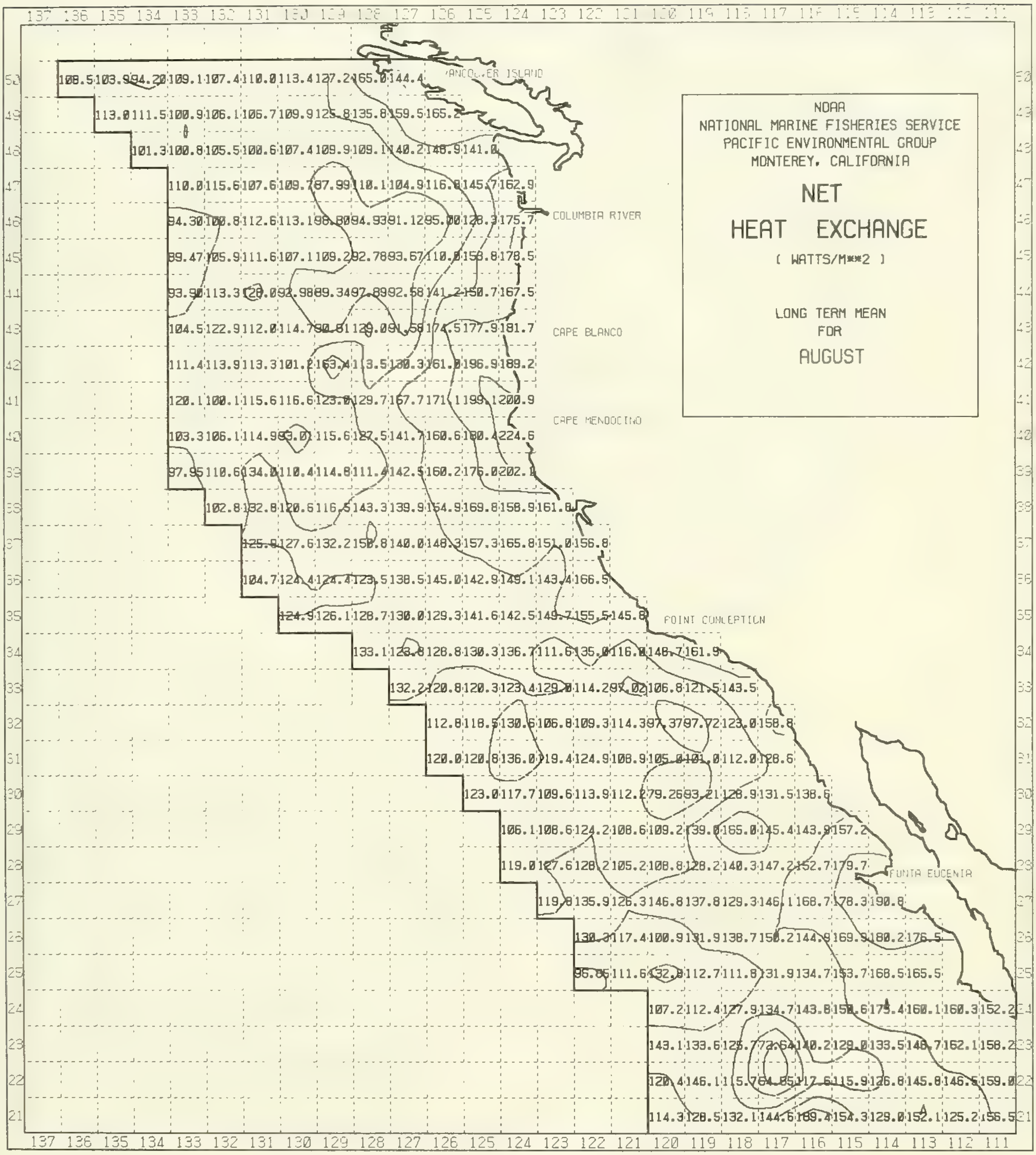

Chart 56.—Composite monthly mean net heat exchange for August.

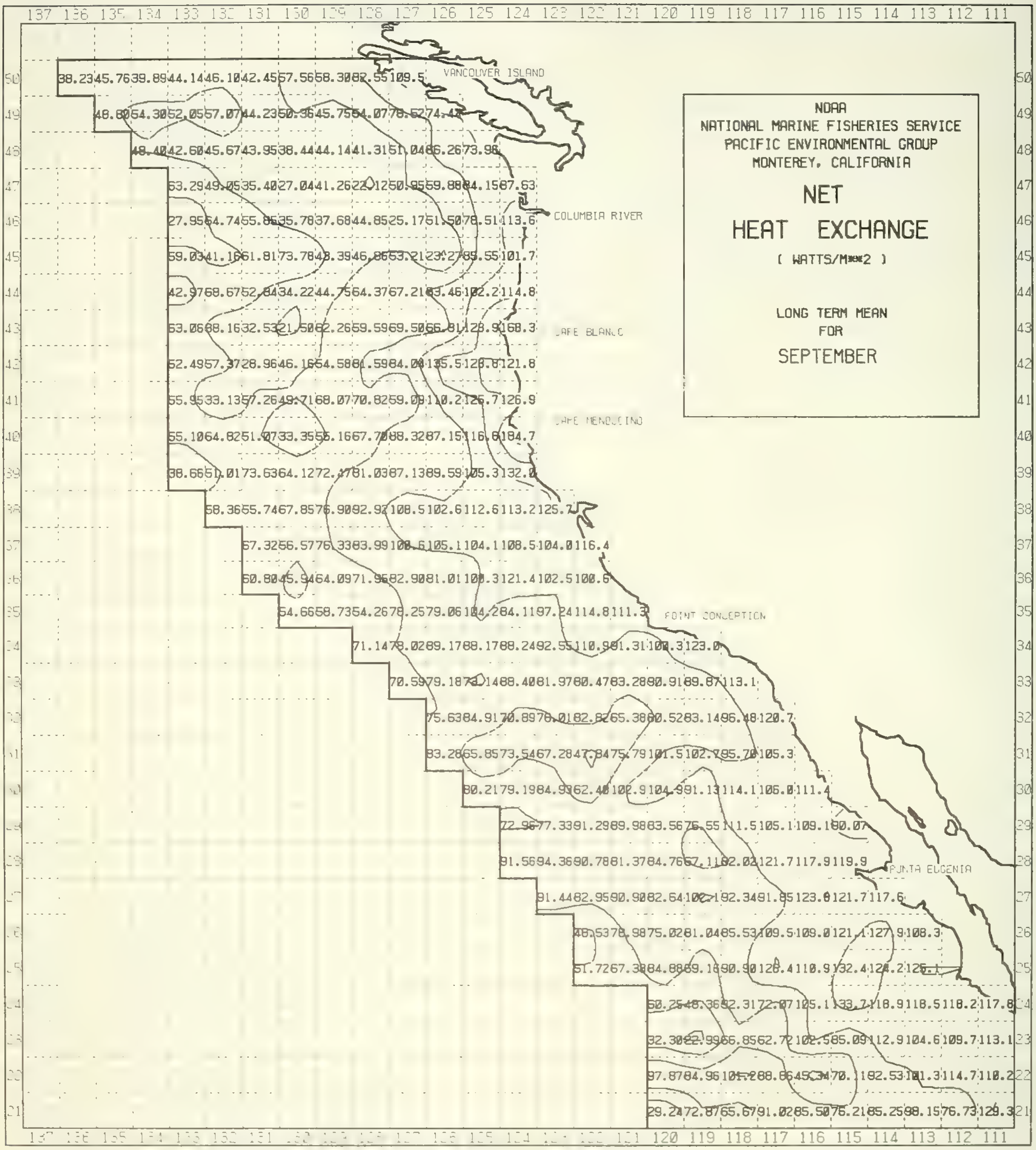

Chart 57.—Composite monthly mean net heat exchange for September.

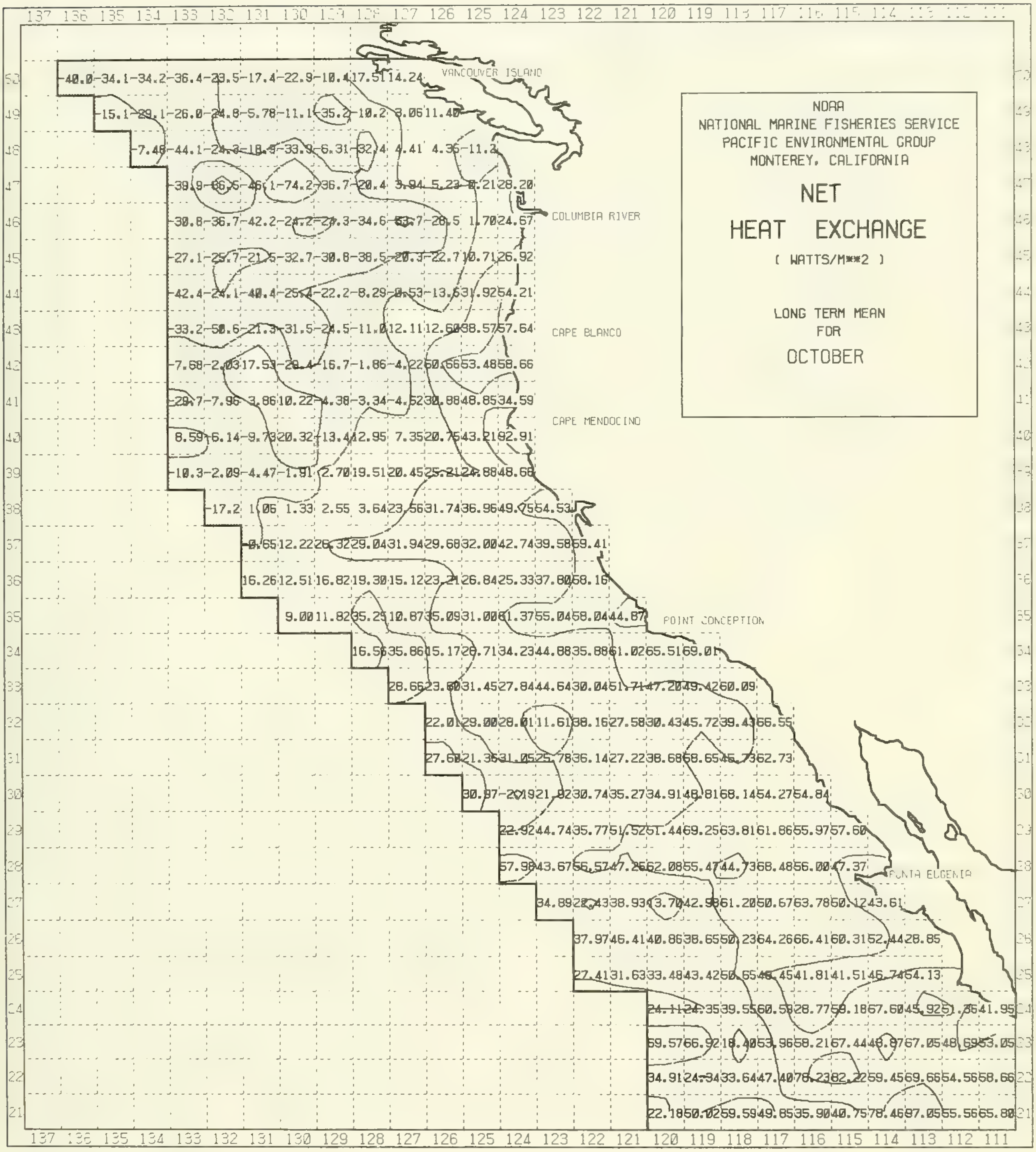

Chart 58.—Composite monthly mean net heat exchange for October.

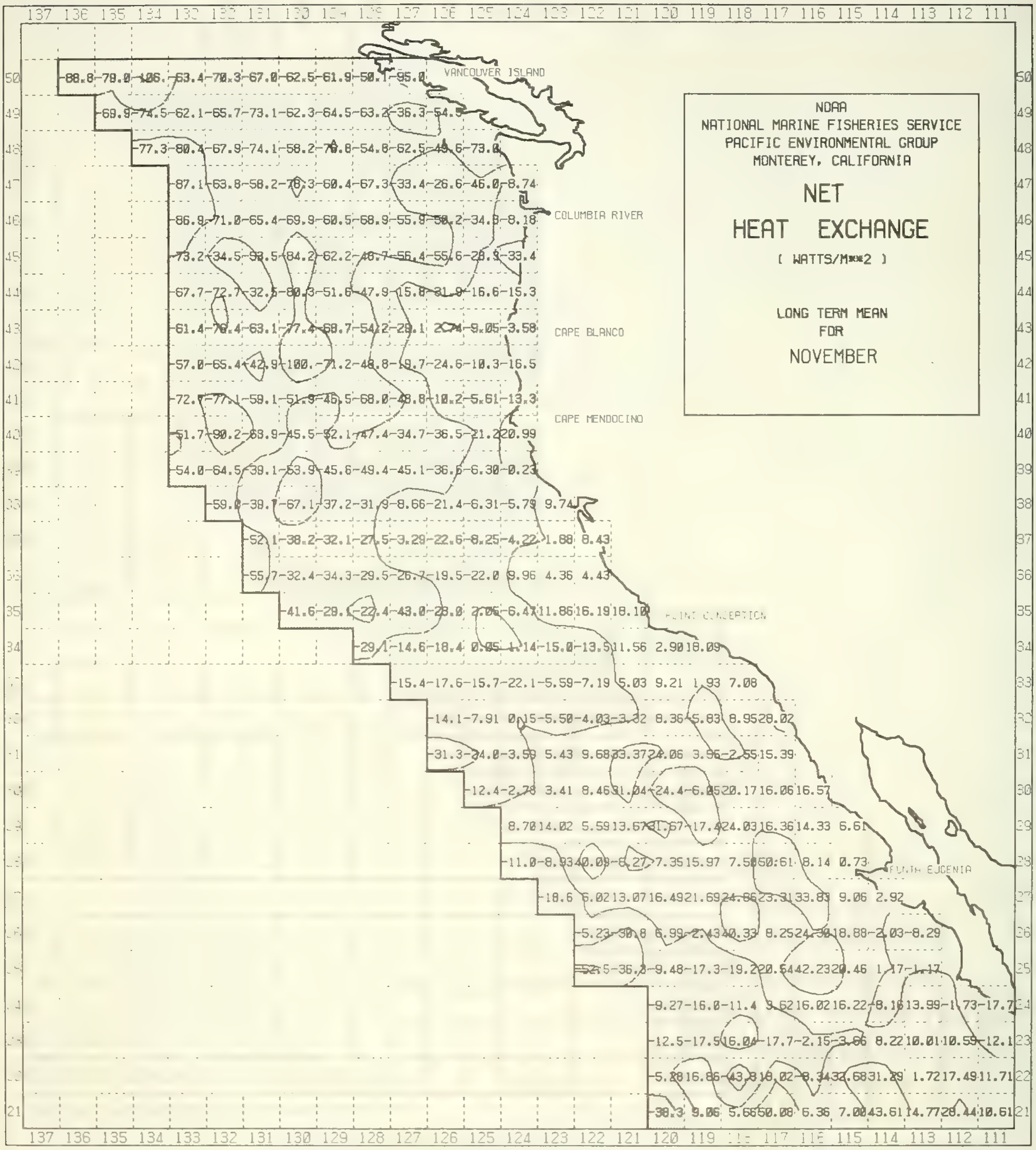

Chart 59.—Composite monthly mean net heat exchange for November.

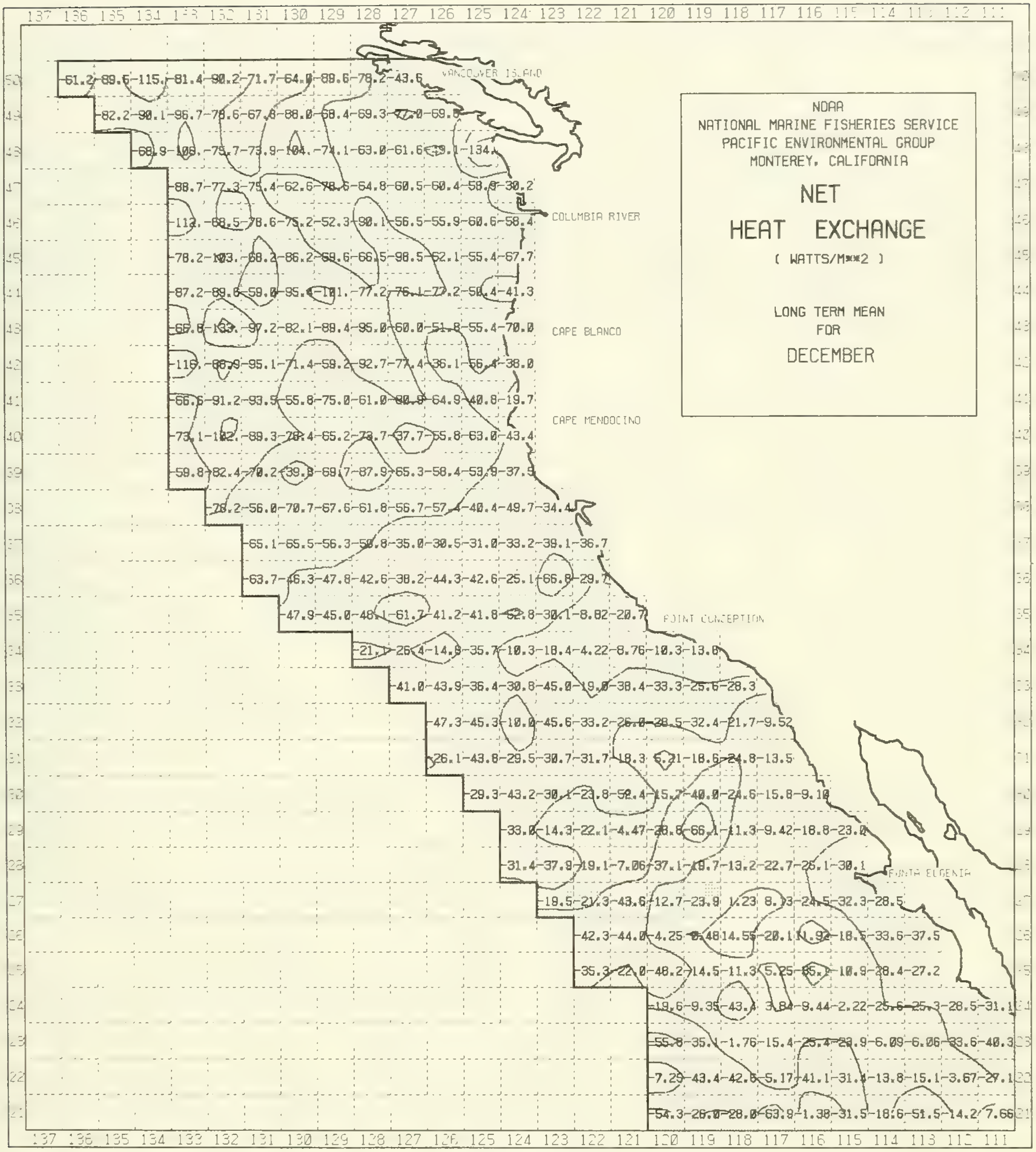

Chart 60.—Composite monthly mean net heat exchange for December.

APPENDIX II

Standard Errors of the Means

The following tables list the computed standard errors of the monthly means by 1° square area for the heat exchange components displayed in Appendix I. Each page contains values for 10 1° squares. Within each group of 10, all 1° squares are defined by a common latitude. The first set of values corresponds to the 1° square adjacent to the coast. The final tabulations refer to the 1° square farthest from the coast.

The standard errors of the means are tabulated for each month and square. The latitude and longitude of the center of the 1° square are listed at the left. Standard errors of the means are tabulated as follows: 1) incident solar radiation, 2) effective back radiation, 3) latent heat flux, 4) sensible heat flux, and 5) net heat exchange. The units are watts per square meter. The last value is the number of observations used to calculate the monthly means and standard errors.

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
21 N	QS	5.46	5.57	5.85	7.26	6.34	7.16	6.53	6.85	5.56	5.43	6.00	4.75
111 W	QB	3.17	3.05	2.54	2.71	2.43	2.33	2.03	2.04	1.75	2.32	2.97	2.85
	QE	11.76	8.98	6.81	10.41	5.91	6.58	5.86	7.02	7.39	7.86	10.66	7.26
	QC	3.34	2.28	2.02	3.30	2.30	2.11	1.74	1.82	1.78	2.07	2.30	1.40
	QN	14.84	12.04	9.42	14.17	8.32	9.73	8.94	10.34	9.59	9.91	13.19	8.61
	OBS	50	53	77	57	81	75	81	66	86	73	52	67
21 N	QS	7.05	7.48	8.15	10.20	7.71	7.84	9.70	9.21	8.26	7.33	6.78	6.03
112 W	QB	4.19	3.88	3.47	3.93	2.92	2.98	3.14	2.95	2.82	3.06	3.54	3.66
	QE	10.42	9.42	10.82	12.06	9.35	9.11	9.69	12.41	13.89	13.35	10.12	10.97
	QC	3.16	2.29	3.56	3.00	2.86	2.34	2.55	2.95	3.47	3.01	1.77	2.65
	QN	13.97	12.35	15.16	15.69	13.61	11.69	14.08	17.50	18.13	16.73	11.82	13.43
	OBS	33	45	37	36	53	57	40	32	43	35	28	40
21 N	QS	8.82	8.35	8.62	11.15	9.09	10.98	11.82	13.02	10.09	10.04	8.85	6.23
113 W	QB	5.37	4.05	4.14	4.21	3.48	3.90	3.41	4.15	3.31	4.29	4.44	4.10
	QE	15.56	12.21	18.45	12.55	12.06	10.41	10.71	17.60	12.89	12.64	18.57	13.33
	QC	4.75	3.64	4.72	3.77	4.04	4.19	3.33	3.44	4.20	4.00	4.28	3.59
	QN	20.47	16.71	24.20	16.63	17.02	13.96	17.07	23.16	14.63	18.43	21.05	16.77
	OBS	23	32	28	31	34	29	29	21	27	23	23	40
21 N	QS	8.84	8.09	9.33	13.24	12.04	17.07	13.66	18.37	14.03	9.68	9.21	7.09
114 W	QB	5.59	4.48	3.73	5.38	4.27	5.82	3.74	5.40	4.56	3.66	4.29	4.59
	QE	15.80	13.48	12.33	20.04	16.69	15.66	19.29	29.16	14.13	17.50	14.00	10.31
	QC	3.86	4.31	3.39	5.33	5.52	6.53	5.73	7.43	4.81	2.63	2.15	2.71
	QN	19.15	19.02	15.28	28.87	22.62	23.05	25.58	38.66	24.21	19.32	15.51	11.87
	OBS	23	31	29	21	21	16	20	13	21	19	21	24
21 N	QS	10.10	11.47	11.79	16.77	12.86	12.67	13.24	19.26	13.92	9.48	8.93	8.52
115 W	QB	5.24	5.38	5.09	6.46	5.00	3.84	4.14	4.97	4.23	4.03	4.17	4.98
	QE	27.58	22.89	18.77	18.90	11.87	11.69	6.44	13.75	16.65	16.29	22.93	16.35
	QC	5.42	6.80	5.97	6.86	4.89	2.91	4.21	3.75	5.28	2.76	8.45	4.40
	QN	32.47	32.50	27.29	27.59	17.30	15.48	15.02	20.26	22.63	22.99	29.78	21.54
	OBS	15	18	26	13	20	17	17	10	18	15	12	21
21 N	QS	10.36	12.58	10.79	16.10	16.08	15.87	13.02	20.08	14.77	10.11	14.36	9.64
116 W	QB	5.70	5.37	4.68	6.96	5.63	4.83	3.36	5.33	4.05	3.71	7.88	6.09
	QE	17.93	13.39	15.42	21.80	13.86	14.50	14.47	13.37	21.37	15.62	22.40	19.06
	QC	4.48	2.65	3.65	7.59	3.40	3.64	4.03	5.44	6.24	2.49	7.01	4.71
	QN	24.52	17.75	20.42	31.12	12.93	19.11	19.02	23.19	33.27	21.55	29.36	25.37
	OBS	12	11	25	14	10	12	22	12	14	14	10	12
21 N	QS	9.45	13.05	10.25	15.49	20.18	11.99	11.20	14.21	12.18	15.59	14.54	9.04
117 W	QB	5.47	6.25	3.87	5.38	7.87	3.50	2.56	3.76	4.19	4.79	8.10	4.50
	QE	16.15	14.31	15.15	16.44	14.76	10.17	21.17	12.12	19.97	18.97	22.11	24.95
	QC	4.12	5.87	4.60	6.59	4.85	3.34	9.35	3.75	5.72	4.53	9.51	7.83
	QN	22.07	21.02	21.75	26.59	15.88	13.73	34.13	17.38	29.09	28.18	34.97	34.35
	OBS	18	12	20	17	9	19	12	17	18	12	11	11
21 N	QS	9.04	12.70	12.73	15.35	13.44	11.27	7.68	12.44	13.43	10.15	10.82	9.00
118 W	QB	4.74	5.18	5.40	5.52	4.28	3.78	2.06	3.70	4.31	3.97	4.51	5.41
	QE	16.21	21.16	14.14	21.41	13.15	13.10	13.78	11.53	13.62	6.57	16.36	15.57
	QC	4.75	6.58	4.21	6.13	5.96	3.82	3.20	6.31	4.10	2.45	4.95	5.67
	QN	23.52	28.89	13.94	34.54	25.12	19.68	19.17	20.55	22.36	11.20	20.42	21.47
	OBS	16	10	10	15	16	16	18	15	16	24	14	16
21 N	QS	12.45	10.44	13.63	8.95	11.15	12.22	13.18	13.29	10.61	9.51	8.19	8.42
119 W	QB	8.31	5.43	5.28	3.01	3.20	4.10	3.69	4.01	3.47	4.12	3.74	5.22
	QE	25.07	17.75	14.49	11.42	15.82	16.70	12.34	11.87	12.47	14.01	10.51	17.44
	QC	6.97	6.71	4.15	5.54	3.99	4.02	4.75	2.04	3.41	3.71	3.30	6.18
	QN	33.32	24.90	19.02	17.20	23.33	22.17	22.96	18.05	19.68	18.88	13.68	21.55
	OBS	10	19	18	24	17	18	19	16	24	27	24	20
21 N	QS	8.66	8.70	13.02	12.91	12.10	10.50	9.33	14.92	14.32	10.18	8.62	6.36
120 W	QB	4.70	4.42	5.60	4.71	4.18	3.61	2.54	4.14	4.55	4.40	4.07	4.34
	QE	10.08	12.47	15.15	9.78	13.77	7.48	7.66	14.44	19.36	13.40	11.67	12.59
	QC	4.49	3.17	3.88	4.18	2.21	2.96	3.32	4.21	6.22	4.32	3.11	4.37
	QN	14.84	16.68	18.27	15.57	20.30	11.83	14.39	23.69	29.84	18.08	16.08	14.81
	OBS	15	26	20	21	23	27	28	16	16	21	23	17

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
22 N	QS	4.03	5.78	4.06	4.92	4.45	5.75	5.07	5.01	4.40	3.90	3.54	3.91
111 W	QB	2.53	3.19	1.89	2.09	1.71	2.01	1.61	1.45	1.44	1.67	1.92	2.55
	QE	8.75	8.08	5.88	6.94	5.40	5.03	5.47	5.43	7.92	7.44	7.10	9.37
	QC	2.33	2.04	1.90	2.65	1.83	2.31	1.80	1.42	1.89	1.54	1.62	1.91
	QN	11.14	11.01	8.17	10.47	7.82	8.16	7.99	7.83	10.97	9.04	8.81	11.38
	OBS	88	62	111	101	136	116	106	115	121	125	113	85
22 N	QS	5.47	6.10	6.49	6.90	5.66	6.33	5.53	5.80	5.15	4.47	4.09	5.37
112 W	QB	3.37	3.28	2.91	2.92	2.16	2.25	1.90	1.76	1.67	1.88	2.01	3.44
	QE	7.70	10.98	7.73	9.97	7.79	5.86	5.53	7.07	7.81	9.31	7.73	9.00
	QC	1.80	2.89	2.63	3.18	2.72	2.48	1.64	1.95	1.86	1.62	1.55	2.02
	QN	9.67	13.95	10.19	13.56	11.04	9.31	7.73	9.99	11.01	11.56	9.86	10.54
	OBS	53	50	65	69	85	90	95	94	92	83	77	49
22 N	QS	6.59	7.10	6.72	7.72	7.71	7.40	7.17	7.61	6.71	5.47	5.01	5.74
113 W	QB	3.76	3.72	3.00	2.88	2.97	2.50	2.31	2.37	2.16	2.46	2.77	3.54
	QE	11.97	9.78	10.57	9.69	6.85	6.52	6.28	7.76	8.70	9.89	8.65	9.98
	QC	2.82	2.17	3.68	4.04	2.41	2.09	2.17	1.83	3.02	2.15	1.60	2.76
	QN	15.59	12.39	15.17	13.48	10.20	9.99	10.28	11.87	12.97	12.37	10.47	13.35
	OBS	41	40	54	54	63	66	74	63	61	60	61	48
22 N	QS	8.06	7.46	6.91	8.10	7.23	7.87	8.74	11.09	8.05	7.56	6.44	4.84
114 W	QB	5.18	4.11	3.24	3.19	2.97	2.43	2.71	2.93	2.69	3.22	3.25	2.95
	QE	14.31	11.21	10.40	10.18	10.29	7.96	5.57	13.16	11.25	12.14	12.47	10.05
	QC	4.45	3.37	3.64	3.03	3.11	3.14	1.99	2.94	3.71	2.63	2.42	2.90
	QN	18.48	14.44	13.73	12.26	14.09	12.57	10.07	13.50	14.16	16.36	15.75	13.10
	OBS	29	36	38	46	53	44	57	31	51	39	29	47
22 N	QS	6.92	7.70	7.82	8.22	10.49	7.44	11.76	10.98	12.66	6.78	10.24	8.54
115 W	QB	4.83	3.93	3.55	3.34	3.94	2.60	3.32	3.27	4.41	3.70	5.26	5.55
	QE	14.87	13.33	11.50	14.18	11.52	11.27	11.10	10.39	16.95	9.35	12.66	17.30
	QC	4.45	4.16	3.13	3.62	3.94	4.71	3.80	3.04	5.20	2.65	3.64	5.73
	QN	19.20	18.81	16.03	17.91	17.69	15.48	18.87	14.23	24.38	11.45	16.29	22.95
	OBS	30	27	41	33	35	31	25	31	25	28	16	20
22 N	QS	10.14	9.63	10.43	15.20	9.65	7.86	13.39	18.24	13.87	8.82	8.76	7.07
116 W	QB	5.53	4.34	4.59	4.82	3.40	2.06	3.83	5.03	5.13	3.97	4.29	4.84
	QE	14.79	11.20	15.20	26.87	13.32	11.94	10.91	12.78	19.17	10.44	14.30	19.87
	QC	5.49	4.21	5.51	7.44	4.99	4.21	3.28	3.87	5.29	3.19	3.06	6.33
	QN	20.10	17.07	22.11	38.30	19.40	16.91	15.58	22.86	25.36	13.66	19.32	25.65
	OBS	20	25	25	14	29	26	21	15	19	17	23	22
22 N	QS	7.43	10.64	9.18	14.00	14.70	10.56	16.18	18.07	12.23	11.06	10.72	8.72
117 W	QB	4.71	5.24	3.85	4.74	5.16	3.13	4.37	6.05	3.68	4.82	5.05	5.11
	QE	18.01	9.88	15.13	13.95	15.01	10.94	11.38	19.56	21.38	12.06	10.08	8.55
	QC	5.51	3.01	4.96	4.64	3.27	3.40	3.94	6.16	5.40	3.66	2.29	3.74
	QN	23.78	13.34	20.58	20.85	21.07	16.83	23.22	28.89	29.25	17.93	11.58	12.92
	OBS	19	23	22	19	15	10	16	14	16	17	16	17
22 N	QS	9.99	11.18	10.23	13.12	8.64	13.69	19.19	13.51	15.02	20.15	10.86	7.70
118 W	QB	6.54	5.54	4.25	5.15	2.81	4.56	6.68	3.52	4.17	8.25	5.42	4.71
	QE	23.24	13.12	13.65	12.50	18.61	14.71	17.24	22.30	22.74	22.73	24.60	19.78
	QC	8.03	6.09	7.02	4.76	5.44	5.68	4.85	5.61	5.38	4.56	4.60	6.52
	QN	31.52	19.18	22.11	14.74	22.55	22.59	22.51	31.23	34.32	27.23	32.18	27.37
	OBS	14	15	16	18	13	16	10	14	13	8	11	21
22 N	QS	11.51	13.73	7.00	12.71	16.09	9.10	10.39	16.20	12.10	13.19	8.42	11.46
119 W	QB	6.44	5.95	2.72	4.78	6.96	2.70	2.84	4.90	4.50	5.89	4.20	8.31
	QE	10.03	21.07	19.38	11.37	11.27	11.26	12.65	17.91	16.09	11.15	11.35	29.94
	QC	4.57	8.23	5.26	4.35	3.51	2.61	3.29	2.88	6.74	5.16	3.06	11.63
	QN	17.07	31.93	24.96	17.78	20.15	14.38	18.29	25.29	24.34	17.34	15.14	41.84
	OBS	13	16	15	21	14	14	16	18	18	16	24	14
22 N	QS	9.02	11.69	10.96	14.95	6.55	25.01	14.52	17.13	13.63	13.47	7.65	12.29
120 W	QB	5.78	5.36	3.97	6.69	2.37	9.36	4.95	6.11	3.85	5.69	4.65	5.63
	QE	14.12	15.05	13.81	13.98	13.49	49.19	18.41	7.86	20.87	14.02	9.60	25.42
	QC	3.34	4.39	4.64	3.37	4.11	13.19	5.05	4.16	2.88	6.40	3.69	6.67
	QN	15.54	23.30	18.92	18.57	16.30	57.58	26.46	15.88	26.87	17.98	12.13	33.78
	OBS	14	17	22	16	29	9	12	12	14	12	18	8

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
23 N	QS	1.45	1.59	1.76	1.89	1.93	2.18	1.79	1.84	1.74	1.46	1.33	1.39
111 W	QB	.95	.89	.83	.79	.76	.83	.59	.57	.59	.62	.75	.94
	QE	3.13	2.71	2.74	2.32	2.35	2.13	2.01	2.42	2.90	2.81	3.38	3.59
	QC	.85	.75	.92	.88	1.05	.97	.67	.63	.68	.66	.77	.88
	QN	4.04	3.48	3.80	3.33	3.60	3.34	2.87	3.26	3.79	3.60	4.14	4.46
	OBS	738	740	782	812	865	781	824	831	786	860	744	678
23 N	QS	3.63	4.73	5.31	5.21	5.05	4.80	4.67	4.75	4.33	3.35	3.38	3.64
112 W	QB	2.34	2.61	2.51	2.12	1.86	1.67	1.54	1.46	1.40	1.45	1.87	2.49
	QE	6.51	7.76	7.77	5.79	5.20	4.03	4.17	6.20	6.65	5.46	6.83	9.11
	QC	1.84	2.64	2.44	2.15	2.28	1.63	1.42	1.56	1.58	1.45	1.88	2.38
	QN	8.34	10.58	10.65	8.43	8.25	6.31	6.27	8.40	9.08	7.51	8.66	11.39
	OBS	118	87	94	106	133	165	143	125	147	147	113	107
23 N	QS	6.61	7.66	8.20	8.46	7.46	7.59	7.12	7.60	6.31	6.47	5.03	5.28
113 W	QB	4.29	4.19	3.64	3.57	2.81	2.67	2.33	2.18	2.20	2.54	2.77	3.30
	QE	12.96	12.23	10.72	7.82	8.13	6.90	5.87	7.24	9.41	7.89	7.87	13.26
	QC	3.18	3.11	3.73	2.83	3.44	3.22	3.03	2.08	2.37	2.42	2.13	3.72
	QN	16.08	15.62	15.83	11.63	12.63	11.83	10.14	10.52	13.07	12.24	10.23	17.79
	OBS	38	34	35	45	65	65	61	59	71	61	62	40
23 N	QS	6.07	7.85	6.62	7.75	6.51	7.26	7.29	6.12	6.82	5.56	4.39	6.01
114 W	QB	4.07	3.98	2.90	2.86	2.51	2.39	2.49	1.73	2.35	2.64	2.24	3.63
	QE	7.55	9.41	8.44	8.52	7.42	6.08	4.91	7.78	9.60	11.29	11.31	12.95
	QC	2.13	3.74	2.78	3.26	3.34	2.51	1.77	2.23	2.60	3.23	2.84	2.84
	QN	8.93	12.23	11.54	13.20	11.30	9.29	8.79	10.86	13.54	14.29	14.69	16.56
	OBS	39	34	46	55	71	67	77	86	65	57	54	36
23 N	QS	5.91	7.90	7.26	7.01	6.95	7.37	8.59	9.14	6.92	6.36	5.59	4.70
115 W	QB	3.70	3.83	3.35	2.75	2.75	2.70	2.66	2.64	2.38	2.75	3.16	3.18
	QE	11.71	11.00	8.08	9.41	9.61	7.39	6.16	10.08	10.34	8.12	8.69	12.66
	QC	3.14	3.52	2.71	2.90	3.37	2.34	1.93	2.93	2.83	2.69	2.39	3.66
	QN	12.44	15.90	11.37	13.32	13.46	10.87	11.43	16.05	13.57	11.49	11.11	16.16
	OBS	35	41	48	63	63	62	54	45	61	60	51	49
23 N	QS	6.66	7.73	7.54	9.07	6.96	7.50	7.53	8.98	7.74	7.09	5.66	5.73
116 W	QB	4.30	4.31	3.46	3.47	2.53	2.48	2.38	2.74	2.97	3.20	3.23	3.72
	QE	10.55	12.50	10.55	11.81	8.22	9.87	4.81	8.69	12.00	8.26	11.22	10.39
	QC	3.63	2.94	4.65	3.91	2.46	3.41	1.94	2.53	4.08	2.07	2.35	2.76
	QN	13.55	14.95	14.38	15.83	11.15	12.87	9.23	13.36	17.10	9.72	13.94	13.54
	OBS	38	33	39	38	61	36	58	48	46	42	43	44
23 N	QS	7.43	8.47	7.39	8.96	9.07	7.61	8.05	11.27	9.63	8.67	8.66	5.14
117 W	QB	5.39	4.52	3.32	3.46	3.63	2.62	2.45	3.71	3.31	4.29	4.71	3.02
	QE	16.59	11.08	9.03	11.96	10.07	8.42	6.10	12.31	12.27	10.03	13.90	9.88
	QC	4.61	3.29	2.92	5.42	4.31	3.36	2.20	2.40	3.85	2.76	3.32	3.76
	QN	20.07	14.95	12.99	16.23	15.04	11.94	9.88	14.93	16.92	14.34	18.94	14.08
	OBS	22	29	51	35	44	41	37	23	33	30	27	46
23 N	QS	7.84	10.35	11.26	7.98	9.55	9.17	10.09	11.40	11.27	10.28	8.95	6.10
118 W	QB	5.05	4.86	5.08	3.08	4.10	2.91	3.31	3.47	4.01	4.27	5.20	3.90
	QE	12.36	13.01	9.38	11.69	12.36	10.67	10.82	12.18	13.36	12.42	8.54	9.92
	QC	3.37	4.42	3.51	4.04	3.75	3.25	3.22	4.62	3.57	2.73	3.33	3.06
	QN	16.53	18.82	14.48	16.29	15.27	15.56	16.99	13.58	19.27	14.65	13.91	13.00
	OBS	26	25	22	30	31	25	24	18	26	23	23	30
23 N	QS	9.48	8.77	9.88	10.46	10.23	9.66	9.92	17.44	10.30	9.76	7.06	8.51
119 W	QB	6.50	4.11	4.62	3.50	4.22	3.37	2.62	5.14	3.81	5.06	4.12	5.19
	QE	16.75	11.40	11.36	11.64	11.27	11.65	8.22	12.99	19.70	10.91	19.86	22.92
	QC	6.00	2.88	3.90	2.54	3.28	2.13	2.28	4.75	6.20	2.30	7.09	4.01
	QN	23.43	15.89	16.69	15.70	14.53	15.31	13.71	22.60	28.80	13.51	24.39	26.49
	OBS	19	29	30	28	31	30	22	15	18	22	14	21
23 N	QS	7.89	10.01	12.54	10.91	13.80	14.43	13.34	12.82	11.29	16.32	8.24	5.87
120 W	QB	5.07	5.01	4.59	3.88	5.77	4.01	3.43	4.06	3.63	6.52	4.45	3.63
	QE	9.57	11.74	14.34	11.91	10.74	10.75	17.54	9.95	13.42	15.13	11.78	19.09
	QC	5.00	3.26	4.84	4.78	3.65	4.27	8.81	3.11	4.31	3.90	2.10	2.52
	QN	14.96	14.18	19.51	17.01	17.67	21.58	23.20	15.45	13.83	22.07	15.33	19.95
	OBS	26	19	13	16	15	13	12	17	20	13	23	21

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
24 N	QS	1.93	2.32	2.35	2.74	2.92	3.06	2.59	2.51	2.26	2.18	1.86	1.82
111 W	QB	1.31	1.29	1.12	1.15	1.18	1.20	.88	.80	.80	.98	1.07	1.31
	QE	3.74	3.55	3.21	2.93	3.06	2.60	3.10	3.57	3.94	4.62	4.63	4.37
	QC	1.05	1.06	1.19	1.15	1.46	1.33	.93	.92	1.00	1.08	1.09	1.16
	QN	4.81	4.63	4.48	4.31	4.75	4.36	4.18	4.59	5.16	5.89	5.72	5.47
	OBS	405	358	421	397	406	401	400	446	395	370	401	370
24 N	QS	1.32	1.53	1.61	1.84	1.93	2.15	1.76	1.78	1.56	1.40	1.25	1.22
112 W	QB	.91	.87	.75	.77	.77	.81	.60	.59	.56	.61	.73	.89
	QE	2.33	2.23	2.11	1.77	1.66	1.46	1.68	2.36	2.51	2.64	2.75	2.93
	QC	.70	.64	.75	.73	.83	.75	.64	.67	.65	.64	.73	.77
	QN	3.07	2.92	3.00	2.68	2.66	2.57	2.54	3.13	3.32	3.37	3.51	3.71
	OBS	841	843	953	938	1015	944	968	914	942	991	895	812
24 N	QS	3.73	4.76	4.49	5.38	5.45	5.25	4.91	4.50	3.88	3.83	3.25	3.46
113 W	QB	2.55	2.59	2.13	2.28	2.33	1.89	1.61	1.46	1.39	1.53	1.78	2.49
	QE	6.97	7.09	5.94	7.10	5.21	4.09	4.16	6.21	7.05	7.39	6.56	8.33
	QC	1.98	2.50	1.96	2.96	2.47	1.76	1.54	1.87	1.91	2.20	1.56	1.82
	QN	8.89	10.00	8.09	9.82	8.12	6.86	6.30	8.56	9.32	10.34	8.53	10.33
	OBS	96	96	137	109	127	154	142	155	158	138	132	102
24 N	QS	6.66	8.10	9.86	10.93	9.15	7.39	9.56	7.45	6.95	5.73	6.55	7.96
114 W	QB	4.59	4.49	4.40	4.13	3.11	2.22	3.10	2.28	2.39	2.72	3.59	5.46
	QE	11.32	18.77	10.77	9.05	6.98	7.53	8.12	6.13	8.27	11.00	13.83	26.35
	QC	3.12	4.63	3.75	3.11	2.85	4.63	3.52	1.83	1.89	3.34	3.41	6.94
	QN	15.20	23.53	15.21	10.65	11.57	13.28	11.88	8.91	10.46	15.14	18.70	33.89
	OBS	31	28	32	29	42	45	40	61	65	50	34	19
24 N	QS	7.12	9.41	8.27	8.30	7.85	9.37	6.60	9.46	6.60	7.03	6.65	7.03
115 W	QB	4.98	5.43	3.70	3.17	2.96	3.30	2.38	2.85	2.51	3.25	3.64	4.39
	QE	12.80	11.56	9.05	7.68	6.91	7.28	5.43	6.54	7.39	11.42	9.98	17.66
	QC	3.53	2.74	3.17	3.40	2.93	2.56	2.09	2.32	2.75	2.56	3.03	5.33
	QN	16.28	13.63	14.26	11.78	10.31	10.75	7.55	11.86	10.86	14.25	13.95	21.08
	OBS	27	27	34	42	52	46	80	43	60	50	38	21
24 N	QS	6.46	6.94	9.21	7.90	6.62	7.04	7.73	6.80	8.60	6.96	5.20	5.43
116 W	QB	4.51	4.10	4.23	2.94	2.45	2.38	2.54	2.12	2.97	3.13	3.00	3.40
	QE	7.91	7.50	10.39	9.23	6.96	6.31	5.10	7.86	9.82	9.04	8.95	11.19
	QC	2.94	2.69	3.73	2.95	2.60	2.79	2.14	2.22	3.15	2.50	2.30	2.68
	QN	11.25	9.05	13.66	12.99	9.57	10.13	8.82	11.11	15.94	12.12	11.30	14.06
	OBS	27	35	36	50	66	60	63	67	51	53	50	38
24 N	QS	6.17	7.86	9.91	9.22	7.70	7.53	7.20	8.49	7.71	7.22	5.35	5.08
117 W	QB	4.01	4.31	4.32	3.62	3.09	2.58	2.29	2.64	2.74	3.19	2.86	3.52
	QE	9.14	9.46	8.90	10.37	7.73	7.12	6.59	9.78	9.39	8.40	11.30	7.50
	QC	3.31	2.63	3.34	3.44	2.50	2.87	2.36	2.60	3.13	2.85	3.30	2.55
	QN	12.07	12.99	10.32	13.27	10.78	10.83	9.21	14.45	14.60	12.75	15.03	10.24
	OBS	38	28	29	40	58	62	64	58	53	52	44	54
24 N	QS	6.49	6.83	7.91	8.78	7.17	5.79	8.81	10.00	8.03	6.70	5.87	5.35
118 W	QB	4.06	3.77	3.45	3.64	2.63	1.85	2.87	3.17	2.70	2.98	3.36	3.58
	QE	8.54	9.09	9.11	11.40	6.42	7.43	6.50	9.09	9.88	7.65	10.40	9.52
	QC	2.31	2.77	3.92	3.86	2.87	2.58	2.66	2.55	3.49	2.37	3.50	2.68
	QN	9.50	11.01	13.45	16.13	9.56	11.04	10.25	12.53	14.62	10.28	14.24	11.71
	OBS	23	40	40	33	52	43	43	35	44	50	46	34
24 N	QS	6.74	7.69	7.62	7.38	7.54	8.41	7.69	9.52	8.04	7.78	6.75	4.79
119 W	QB	4.26	4.01	3.48	2.87	2.78	2.70	2.32	2.81	2.94	3.64	4.18	3.25
	QE	7.95	11.89	9.42	8.82	9.71	7.09	6.87	9.79	16.24	10.41	12.65	6.38
	QC	3.12	4.00	2.76	3.30	3.44	3.15	2.28	3.56	3.28	2.64	3.08	2.06
	QN	11.16	16.03	12.40	10.48	14.19	11.88	9.85	14.72	21.28	14.10	15.58	8.06
	OBS	28	35	46	41	51	36	45	35	30	33	31	38
24 N	QS	6.73	7.64	7.71	8.57	7.69	7.67	7.35	12.76	10.05	9.39	6.38	5.33
120 W	QB	4.59	3.77	3.24	3.39	2.92	2.49	2.36	4.05	3.40	4.14	3.55	3.65
	QE	10.47	6.95	9.06	8.64	8.18	11.11	7.02	12.95	14.73	12.40	11.30	8.88
	QC	3.49	2.97	3.13	3.03	3.80	3.28	2.81	3.34	5.45	3.39	2.46	2.55
	QN	13.65	9.41	12.26	11.58	11.08	16.58	10.28	20.62	18.21	17.60	14.18	10.10
	OBS	31	47	39	34	38	25	31	23	25	31	37	37

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
25 N	QS	1.26	1.46	1.59	1.86	1.95	2.14	1.85	1.78	1.56	1.36	1.25	1.14
113 W	QB	.88	.85	.76	.79	.78	.81	.63	.60	.57	.61	.76	.87
	QE	2.29	2.18	1.97	1.60	1.46	1.35	1.43	2.21	2.41	2.45	2.58	2.71
	QC	.67	.68	.69	.71	.68	.65	.61	.72	.76	.65	.70	.68
	QN	2.98	2.83	2.72	2.37	2.34	2.38	2.40	3.06	3.30	3.27	3.34	3.36
	OBS	909	903	1010	1000	1052	1020	1018	991	979	992	955	891
25 N	QS	3.45	4.61	5.31	5.37	5.44	5.55	5.63	4.83	4.43	3.65	3.71	3.72
114 W	QB	2.42	2.59	2.65	2.22	2.12	2.04	1.90	1.60	1.50	1.72	2.16	2.72
	QE	6.77	7.73	7.05	5.50	5.09	4.02	4.18	4.25	5.79	6.95	7.34	8.30
	QC	1.95	2.85	2.67	2.09	2.43	1.86	2.05	1.51	1.79	1.87	1.93	2.08
	QN	8.46	11.00	10.25	7.93	7.63	6.49	7.81	6.70	8.26	9.18	9.41	10.34
	OBS	104	85	91	112	128	148	123	161	139	134	111	90
25 N	QS	8.89	8.02	10.00	7.84	8.61	8.26	7.48	8.00	7.96	6.21	5.91	5.67
115 W	QB	5.96	4.51	4.13	3.20	3.07	3.17	2.40	2.62	2.94	2.84	3.36	4.40
	QE	9.39	9.93	11.76	10.75	5.27	5.79	4.71	7.17	7.68	9.42	12.29	17.58
	QC	2.61	3.46	3.59	3.23	2.80	2.94	2.58	2.26	2.55	2.54	2.70	4.58
	QN	11.49	12.98	16.86	13.96	10.96	9.67	9.67	10.30	11.54	13.13	16.42	21.14
	OBS	20	25	29	49	55	48	68	55	55	51	35	24
25 N	QS	12.03	8.83	10.50	11.81	8.37	9.75	9.75	9.25	9.02	10.95	7.03	10.73
116 W	QB	9.23	4.84	4.77	5.11	3.04	3.34	3.31	3.15	2.98	5.33	4.44	7.13
	QE	22.60	12.54	13.86	7.34	6.82	6.96	6.72	8.18	11.61	12.52	9.26	24.91
	QC	6.43	5.21	4.50	4.46	3.59	2.00	2.57	2.74	3.60	3.04	3.85	8.40
	QN	27.97	16.70	17.60	11.33	12.36	7.60	11.73	11.00	17.25	17.26	13.37	33.51
	OBS	13	20	21	19	32	29	37	37	32	20	26	9
25 N	QS	8.25	8.44	9.30	9.14	8.00	9.44	8.60	7.40	9.55	6.87	5.86	7.25
117 W	QB	6.14	5.08	4.15	3.65	2.64	3.07	2.81	2.36	3.43	3.16	3.51	5.04
	QE	10.91	12.72	7.65	8.89	6.66	7.60	5.60	7.12	7.32	9.59	12.11	10.77
	QC	4.77	6.13	3.30	2.86	2.48	2.59	2.66	1.56	3.20	3.41	3.02	3.60
	QN	15.54	17.58	12.29	11.62	10.82	12.51	10.05	10.01	11.65	14.01	15.17	14.46
	OBS	21	23	30	34	49	36	48	53	36	37	32	20
25 N	QS	6.72	7.92	10.09	9.41	6.35	6.71	7.30	7.16	8.21	7.25	5.59	4.94
118 W	QB	4.28	4.91	4.71	3.71	2.29	2.42	2.37	2.51	2.71	3.47	3.19	3.38
	QE	11.20	12.80	9.33	9.50	7.23	6.91	4.99	7.48	9.26	7.10	13.56	7.73
	QC	3.79	5.16	3.48	3.93	2.77	2.66	1.81	2.33	2.34	2.48	3.97	1.94
	QN	15.44	17.74	14.26	14.23	10.25	9.16	8.76	9.60	13.51	9.20	18.44	9.80
	OBS	24	24	27	41	57	49	64	54	43	48	39	42
25 N	QS	6.69	6.28	8.17	8.50	7.95	6.08	6.41	7.29	6.79	6.03	5.62	5.01
119 W	QB	4.21	3.16	3.48	3.26	3.19	2.14	2.04	2.18	2.59	2.88	3.26	3.67
	QE	7.88	12.32	7.41	9.95	7.75	5.66	7.32	8.73	7.55	6.98	14.73	8.49
	QC	2.70	3.54	1.98	3.45	2.89	1.96	2.32	2.40	2.15	1.95	3.96	2.53
	QN	9.59	15.39	11.35	13.81	11.20	8.02	10.57	12.27	10.03	10.14	19.50	10.20
	OBS	33	27	38	39	54	64	51	54	53	53	40	36
25 N	QS	7.08	7.84	8.03	6.42	6.01	7.88	7.36	9.65	9.16	7.25	4.88	6.56
120 W	QB	5.27	3.79	3.64	2.74	2.44	2.58	2.36	3.39	3.51	3.85	2.67	4.41
	QE	10.71	12.48	6.20	8.43	8.22	5.52	5.75	8.05	8.44	10.81	12.27	11.08
	QC	3.68	4.03	2.72	2.24	3.71	2.19	1.66	2.23	2.27	3.16	2.84	3.07
	QN	14.30	17.42	9.17	9.63	10.53	8.71	9.37	11.72	11.92	14.61	15.54	14.42
	OBS	21	31	40	47	53	40	46	44	35	40	49	29
25 N	QS	6.66	8.06	8.20	9.24	8.68	7.88	7.11	8.75	7.74	8.33	5.65	7.44
121 W	QB	4.76	4.42	3.67	3.31	3.39	2.62	2.36	3.08	2.66	3.95	3.66	4.71
	QE	11.10	8.49	12.94	6.50	7.94	6.28	7.13	9.58	11.89	10.00	16.71	11.63
	QC	3.19	3.14	4.17	2.51	2.79	3.81	2.64	3.85	2.93	2.52	3.72	3.68
	QN	14.03	9.94	18.72	10.74	11.56	11.12	11.37	13.46	16.05	14.07	19.93	16.04
	OBS	25	28	30	33	38	35	49	34	35	38	26	22
25 N	QS	6.95	7.64	8.43	7.62	7.91	10.65	6.61	8.75	11.59	8.87	5.57	4.78
122 W	QB	4.49	3.67	3.65	2.83	2.70	3.55	1.89	2.64	4.15	3.81	3.22	3.40
	QE	11.42	9.75	9.63	9.97	8.92	8.89	9.74	11.21	12.08	10.16	16.19	10.08
	QC	3.14	3.13	3.44	2.77	3.08	2.43	3.20	3.04	3.61	2.76	3.96	2.59
	QN	14.51	12.99	13.74	12.65	12.97	11.81	13.07	17.16	16.38	13.28	19.78	12.34
	OBS	26	31	31	44	41	24	32	28	27	27	27	38

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
26 N	QS	2.21	2.56	2.88	3.55	3.42	3.71	3.43	3.17	2.90	2.35	2.16	1.86
113 W	QB	1.64	1.55	1.40	1.49	1.42	1.41	1.23	1.14	1.11	1.12	1.34	1.49
	QE	4.57	3.70	3.53	2.74	2.75	2.07	2.71	3.61	4.82	5.02	4.71	5.16
	QC	1.37	1.10	1.34	1.28	1.23	1.08	1.05	1.32	1.27	1.39	1.17	1.41
	QN	5.90	4.72	4.88	4.25	4.31	3.82	4.37	5.12	6.41	6.62	5.84	6.55
	OBS	273	297	304	285	325	321	277	290	297	311	313	289
26 N	QS	1.29	1.50	1.66	1.98	2.09	2.24	1.99	1.80	1.70	1.42	1.28	1.17
114 W	QB	.97	.91	.82	.86	.85	.88	.71	.65	.65	.68	.82	.95
	QE	2.51	2.35	2.00	1.75	1.66	1.56	1.37	2.01	2.38	2.44	2.88	3.01
	QC	.74	.77	.78	.78	.78	.79	.65	.73	.75	.73	.78	.83
	QN	3.27	3.09	2.80	2.60	2.54	2.59	2.41	2.92	3.26	3.22	3.71	3.79
	OBS	828	861	989	927	929	908	911	926	922	924	854	807
26 N	QS	4.23	4.28	5.50	6.22	6.26	6.26	6.45	5.84	5.14	4.58	4.12	4.11
115 W	QB	3.09	2.66	2.63	2.52	2.37	2.33	2.23	1.89	1.82	2.18	2.30	3.27
	QE	6.17	6.73	7.26	4.64	5.62	4.72	4.07	4.85	5.72	7.80	7.68	10.15
	QC	2.40	2.45	2.81	2.64	2.74	2.73	1.92	1.62	1.96	3.04	2.14	3.06
	QN	8.13	9.13	9.71	8.09	9.06	7.02	7.06	7.64	8.30	10.72	10.27	13.48
	OBS	85	76	78	92	94	110	109	109	106	89	87	65
26 N	QS	7.45	11.47	11.18	9.33	7.07	7.51	8.29	8.85	8.01	7.08	4.76	7.43
116 W	QB	5.20	7.52	5.17	4.15	2.75	2.64	2.90	3.04	2.87	2.92	2.94	5.51
	QE	12.38	23.49	12.37	10.73	7.03	7.59	4.61	6.74	8.47	11.64	10.45	13.64
	QC	3.94	8.96	2.89	3.68	3.11	3.34	2.25	2.35	2.82	3.06	2.34	4.03
	QN	15.57	32.54	14.59	13.53	10.70	10.97	7.67	10.26	12.68	16.27	13.42	17.64
	OBS	24	16	24	39	57	57	54	43	49	44	44	20
26 N	QS	9.21	11.39	13.82	10.93	10.67	9.32	8.07	9.31	8.78	6.58	8.00	8.67
117 W	QB	7.70	6.89	6.52	4.15	4.10	3.28	2.96	2.88	3.37	3.44	4.93	6.38
	QE	17.90	21.38	26.25	9.07	6.29	7.75	6.18	6.44	8.13	8.55	9.90	19.41
	QC	3.42	7.55	8.56	4.65	2.19	3.53	2.36	2.76	2.93	2.30	3.77	4.75
	QN	22.70	27.32	37.42	14.38	10.58	12.53	9.63	11.47	12.60	10.91	14.12	23.41
	OBS	12	14	11	31	28	31	45	40	34	31	25	15
26 N	QS	7.53	8.41	10.52	11.90	9.64	6.33	6.77	8.74	6.44	8.46	8.19	9.59
118 W	QB	4.69	4.97	5.06	4.93	3.37	2.09	1.84	2.93	2.58	4.18	4.98	6.80
	QE	10.11	11.51	11.43	8.45	7.69	6.39	5.04	7.06	7.30	8.27	10.12	14.26
	QC	4.08	3.10	3.18	4.29	2.32	2.19	3.70	2.76	2.87	1.94	2.87	4.93
	QN	15.19	13.15	15.95	14.61	9.82	8.16	9.14	11.35	9.75	10.71	13.81	19.05
	OBS	25	21	28	23	31	31	32	38	50	31	20	13
26 N	QS	8.29	10.01	11.96	10.07	7.73	8.64	8.25	10.61	12.01	10.77	6.20	8.01
119 W	QB	5.60	6.49	5.37	4.23	2.61	2.98	2.77	3.91	4.62	4.70	3.86	5.69
	QE	14.53	19.00	12.77	9.63	6.40	8.43	5.22	9.47	12.59	11.57	7.35	13.20
	QC	2.55	6.37	4.14	3.13	2.54	3.61	2.88	3.33	5.02	3.16	2.71	3.73
	QN	17.42	24.50	17.24	12.93	8.69	11.06	10.17	14.38	17.22	16.37	9.30	16.71
	OBS	17	21	19	30	36	27	38	35	22	25	32	17
26 N	QS	7.17	9.60	9.22	9.93	7.56	7.87	6.23	7.96	8.22	6.88	5.80	5.26
120 W	QB	4.35	5.36	5.03	3.62	3.15	2.66	1.97	2.77	3.19	3.24	3.30	4.22
	QE	10.03	10.42	11.70	8.51	7.03	5.19	6.83	9.32	11.14	8.35	11.17	10.15
	QC	2.53	4.80	3.05	3.22	2.43	2.05	2.62	3.00	3.66	2.41	2.30	2.73
	QN	12.66	14.08	15.77	10.94	9.99	8.35	10.54	14.26	15.74	11.18	13.78	11.82
	OBS	21	16	27	34	52	49	48	39	42	45	32	30
26 N	QS	6.51	10.67	8.39	8.41	8.63	6.58	10.06	7.53	8.21	7.63	5.28	4.56
121 W	QB	4.02	5.19	3.99	3.38	3.24	2.21	3.39	2.49	3.02	3.65	3.19	3.34
	QE	10.25	11.94	8.90	8.73	10.58	6.29	7.79	8.21	8.19	7.63	14.94	10.51
	QC	4.16	3.11	3.48	2.75	3.23	2.13	2.28	3.15	2.28	2.48	4.83	4.33
	QN	14.32	11.15	13.91	12.18	13.15	8.54	11.02	12.48	11.88	10.61	19.90	14.89
	OBS	33	18	29	46	45	59	39	48	42	37	35	32
26 N	QS	6.26	6.95	6.93	9.52	7.41	7.09	6.34	7.87	7.36	6.99	5.25	4.59
122 W	QB	4.32	4.32	3.59	4.19	2.59	2.46	1.96	2.76	2.88	3.29	3.48	3.16
	QE	10.36	11.31	7.67	9.84	7.44	5.38	5.85	8.59	8.83	10.93	9.39	15.24
	QC	3.22	3.52	3.26	2.83	2.75	1.86	2.12	3.43	3.32	2.53	2.29	4.65
	QN	13.81	15.06	10.57	11.53	11.12	8.82	9.21	12.72	12.26	14.57	11.62	20.00
	OBS	24	26	40	35	45	47	50	42	40	43	45	30

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
27 N	QS	1.99	2.29	2.57	3.13	3.11	3.51	3.22	2.79	2.69	2.25	1.96	1.63
114 W	QB	1.52	1.45	1.30	1.40	1.28	1.41	1.18	1.08	1.09	1.13	1.36	1.36
	QE	4.11	3.43	2.83	2.62	2.53	2.22	2.15	3.38	3.97	4.03	4.21	4.16
	QC	1.43	1.16	1.12	1.26	1.17	1.14	1.08	1.26	1.25	1.23	1.13	1.20
	QN	5.53	4.50	3.92	3.83	3.81	3.88	3.87	4.94	5.57	5.29	5.44	5.26
	OBS	324	342	388	352	387	352	361	317	375	380	348	373
27 N	QS	1.29	1.51	1.80	2.06	2.19	2.43	2.25	1.97	1.95	1.59	1.31	1.19
115 W	QB	1.01	.95	.89	.91	.88	.94	.81	.73	.80	.78	.87	1.01
	QE	2.45	2.32	1.92	1.78	1.72	1.60	1.56	1.99	2.39	2.65	2.61	3.18
	QC	.84	.90	.84	.88	.89	.83	.78	.83	.85	.94	.80	.95
	QN	3.22	3.10	2.79	2.73	2.76	2.73	2.70	3.02	3.42	3.66	3.38	4.07
	OBS	744	764	855	816	854	812	803	830	779	825	763	685
27 N	QS	4.75	4.76	6.75	6.69	7.03	6.81	6.88	6.44	5.58	6.36	4.89	5.23
116 W	QB	3.28	2.98	3.27	2.97	2.81	2.42	2.23	2.16	2.17	3.02	3.06	4.57
	QE	8.54	8.45	7.34	4.81	7.75	5.49	6.45	4.56	6.10	8.59	8.92	11.30
	QC	2.12	3.51	3.05	2.01	2.72	3.04	2.66	1.81	2.32	3.01	2.56	4.09
	QN	11.32	11.97	11.55	7.32	10.55	9.30	9.04	8.10	8.51	11.69	10.93	15.38
	OBS	58	71	61	75	73	70	69	88	96	58	54	39
27 N	QS	6.79	8.37	8.52	8.57	7.97	7.32	7.71	7.36	6.57	7.16	5.90	7.11
117 W	QB	4.86	5.29	4.25	3.46	2.87	2.56	2.52	2.28	2.60	3.02	3.68	5.81
	QE	11.86	10.36	11.77	7.96	6.15	5.47	4.55	5.03	5.66	7.39	11.60	12.19
	QC	2.55	3.34	6.79	3.45	2.52	1.89	2.32	2.03	1.79	2.62	4.44	5.74
	QN	13.34	13.70	17.40	10.84	9.46	7.21	8.32	8.81	8.24	12.02	15.39	16.53
	OBS	24	30	30	40	44	49	59	55	63	43	38	19
27 N	QS	7.36	12.53	14.10	11.56	10.26	8.94	7.25	8.46	7.90	9.79	6.55	7.50
118 W	QB	5.69	7.25	5.86	4.33	3.63	3.12	2.44	2.74	3.32	4.51	4.74	5.48
	QE	10.04	14.91	15.18	11.49	7.62	6.58	5.25	6.58	8.98	7.49	10.72	12.79
	QC	1.88	5.19	6.14	4.12	2.35	2.97	2.34	2.70	2.91	2.52	3.86	4.74
	QN	10.78	18.91	21.13	17.04	10.56	10.76	7.96	12.30	12.34	11.49	14.88	16.03
	OBS	21	15	15	30	31	41	61	44	43	25	27	16
27 N	QS	8.39	9.89	12.80	10.92	9.22	10.57	10.02	10.06	8.34	9.10	8.91	8.16
119 W	QB	5.50	6.74	6.12	4.39	3.63	3.37	3.86	3.78	3.29	4.25	5.85	6.01
	QE	11.42	5.47	14.87	9.28	11.07	7.63	9.51	6.26	9.94	11.93	9.69	26.62
	QC	4.69	6.23	5.55	4.88	2.63	2.97	4.66	2.92	3.80	3.45	2.35	6.49
	QN	16.10	12.41	21.80	16.13	13.70	13.76	14.82	10.50	14.91	16.17	11.71	33.65
	OBS	15	10	10	32	29	29	24	30	34	33	22	12
27 N	QS	6.92	13.47	9.26	13.42	7.31	6.43	8.72	10.28	10.52	8.60	10.93	10.05
120 W	QB	5.31	8.37	4.74	6.11	2.73	2.23	3.19	3.69	4.45	4.26	8.03	7.52
	QE	17.46	33.84	14.36	10.42	7.89	10.15	5.70	7.26	11.80	15.13	16.54	15.32
	QC	4.60	10.59	4.35	3.59	4.85	7.14	1.78	2.97	3.90	3.86	2.81	3.74
	QN	21.44	43.57	19.41	17.43	10.89	9.55	8.50	11.43	15.86	18.81	17.20	18.64
	OBS	21	11	19	18	28	24	26	33	32	23	12	12
27 N	QS	7.66	12.85	12.20	10.04	9.00	10.24	9.65	11.81	11.20	8.27	7.93	9.57
121 W	QB	5.67	7.03	5.30	4.29	3.34	4.23	3.15	4.41	4.05	4.32	4.90	6.86
	QE	12.10	7.29	15.32	12.25	9.25	10.69	6.91	9.41	12.61	11.18	11.88	23.71
	QC	2.32	3.44	7.58	4.21	4.00	2.22	2.58	2.20	4.38	2.72	3.42	6.90
	QN	14.48	9.23	25.29	16.63	13.91	12.87	10.75	15.35	20.34	13.64	15.49	30.18
	OBS	20	17	17	34	38	17	27	29	23	31	23	8
27 N	QS	5.96	6.98	8.26	9.74	8.43	7.44	7.71	8.58	8.43	7.44	6.04	4.58
122 W	QB	4.14	3.88	3.77	3.60	3.12	2.70	2.64	2.86	3.18	4.25	3.47	3.51
	QE	8.24	16.62	9.98	9.77	8.74	7.32	6.28	8.37	10.63	10.71	11.03	9.88
	QC	2.04	5.02	3.33	3.55	2.76	1.68	2.63	3.43	3.94	2.83	3.08	2.73
	QN	10.44	20.56	12.74	13.97	12.45	9.60	9.31	14.41	14.00	13.40	14.12	12.48
	OBS	24	21	33	39	46	45	41	41	32	35	27	35
27 N	QS	5.46	7.51	7.35	9.13	6.36	5.84	7.48	7.10	6.03	5.82	5.48	4.85
123 W	QB	3.55	4.82	3.23	3.76	2.42	2.04	2.55	2.39	2.26	2.62	3.30	3.59
	QE	9.25	7.54	10.10	7.38	7.03	5.28	7.72	5.72	5.87	7.13	12.78	12.05
	QC	2.82	2.51	3.26	2.56	2.47	2.23	2.45	2.27	1.77	2.29	3.89	3.89
	QN	12.63	8.54	13.13	10.33	10.35	7.28	10.81	9.07	8.01	9.87	17.00	15.47
	OBS	36	30	41	45	57	76	48	56	56	55	38	33

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
28 N	QS	1.56	2.01	2.32	2.75	3.01	3.15	3.28	2.76	2.69	2.09	1.66	1.49
115 W	QB	1.24	1.26	1.16	1.16	1.16	1.15	1.13	1.01	1.04	1.07	1.16	1.26
	QE	3.16	2.95	2.50	2.17	2.02	1.78	1.93	2.21	2.93	3.36	3.67	3.91
	QC	1.14	1.06	1.00	.98	1.07	.97	.96	.86	1.05	1.10	1.19	1.11
	QN	4.21	3.89	3.49	3.34	3.40	3.39	3.65	3.50	4.42	4.55	4.85	4.88
	OBS	486	451	515	497	494	466	423	486	481	487	462	448
28 N	QS	1.47	1.86	2.17	2.50	2.58	2.20	2.61	2.44	2.48	1.94	1.51	1.39
116 W	QB	1.18	1.16	1.05	1.05	.98	.76	.86	.83	.96	1.00	1.06	1.23
	QE	2.86	2.26	2.07	2.11	2.04	1.73	1.55	2.16	2.34	2.64	3.10	3.38
	QC	.95	.88	.92	.99	.96	.81	.80	.87	.85	.93	.92	1.14
	QN	3.74	3.08	3.03	3.15	3.26	2.80	2.98	3.47	3.66	3.66	4.01	4.39
	OBS	543	526	584	571	585	619	560	593	549	602	548	505
28 N	QS	4.15	5.37	7.08	8.54	9.12	6.07	9.08	7.87	7.71	6.16	5.82	4.89
117 W	QB	3.09	3.71	3.48	3.26	3.42	2.09	2.85	2.68	3.01	3.26	3.45	4.33
	QE	7.49	7.60	7.14	6.01	6.55	5.07	6.03	6.12	5.70	6.73	8.14	12.46
	QC	2.11	1.99	2.82	2.57	3.96	2.92	2.60	1.98	2.09	2.45	3.44	4.14
	QN	9.56	9.58	9.79	8.82	9.85	8.25	10.89	9.39	8.86	9.33	11.51	15.77
	OBS	51	52	50	52	42	46	40	48	53	48	38	46
28 N	QS	6.93	9.46	11.08	10.80	10.65	8.81	9.36	8.63	9.28	8.00	8.10	7.31
118 W	QB	5.27	5.60	5.43	4.59	4.06	3.10	2.97	2.94	3.84	4.16	6.12	6.06
	QE	7.16	13.40	11.77	12.50	9.13	4.98	5.82	5.81	8.81	9.69	15.66	19.61
	QC	3.17	2.46	3.31	4.53	4.18	3.78	2.33	2.22	3.59	2.33	3.54	5.45
	QN	10.39	15.58	11.66	15.48	13.88	10.85	10.75	10.25	14.29	12.38	17.22	24.21
	OBS	25	20	15	22	30	33	44	51	37	34	18	16
28 N	QS	5.70	8.46	9.69	8.77	6.42	5.58	6.19	7.73	9.98	8.00	7.45	10.74
119 W	QB	5.17	5.00	4.80	3.60	2.61	2.01	2.03	2.71	3.84	3.82	4.68	9.08
	QE	7.95	9.08	9.17	7.65	6.38	7.66	4.94	6.47	9.37	9.06	8.07	26.73
	QC	3.02	2.07	3.39	2.61	2.33	2.75	1.83	1.91	2.57	1.96	3.29	13.04
	QN	10.07	10.81	13.92	9.55	9.77	10.10	7.22	9.97	12.20	12.08	11.20	38.88
	OBS	22	27	26	38	48	56	61	50	29	37	30	13
28 N	QS	8.43	12.95	9.52	8.44	10.53	8.10	8.86	8.06	7.09	10.05	8.42	8.52
120 W	QB	7.04	7.95	4.97	3.56	4.03	2.83	2.91	3.26	3.17	5.30	5.73	7.12
	QE	23.67	28.83	9.94	11.52	8.81	6.38	7.24	5.32	8.00	9.46	9.28	18.57
	QC	4.12	9.94	3.57	4.08	4.21	2.89	3.26	1.76	2.51	3.07	2.52	7.29
	QN	27.40	37.55	13.17	14.76	13.53	12.24	9.90	9.09	10.98	14.33	12.76	25.22
	OBS	12	12	31	40	32	31	30	33	42	21	23	16
28 N	QS	9.49	10.33	10.80	9.61	11.93	9.04	12.34	7.09	9.00	9.07	7.66	7.94
121 W	QB	7.65	6.56	5.33	3.79	5.43	3.01	4.40	2.48	3.57	4.80	5.15	6.65
	QE	19.47	13.23	8.45	8.83	8.36	7.58	7.18	8.16	10.66	10.58	13.07	8.93
	QC	8.41	6.76	5.95	3.98	2.58	3.42	3.19	2.86	3.87	3.41	3.29	2.61
	QN	28.61	15.83	13.01	14.30	13.18	12.65	8.98	12.49	15.14	14.13	16.49	10.65
	OBS	10	8	18	34	27	34	24	35	28	29	24	16
28 N	QS	6.32	9.41	8.97	12.08	8.51	8.14	5.30	9.79	8.42	9.86	8.41	7.05
122 W	QB	4.86	5.79	4.75	4.78	3.09	2.60	1.94	3.30	3.74	5.21	6.09	5.72
	QE	10.90	9.17	11.75	9.80	8.06	9.19	5.88	6.73	6.45	8.09	9.94	11.64
	QC	3.08	4.49	4.66	4.16	3.74	3.23	2.79	3.14	2.09	6.54	4.68	5.61
	QN	14.19	14.22	17.44	14.63	11.23	12.20	8.12	11.32	8.50	14.52	15.68	16.65
	OBS	28	18	28	19	32	32	35	37	29	23	16	22
28 N	QS	6.61	8.59	9.74	7.81	8.10	10.87	7.47	8.72	9.21	7.39	5.32	4.92
123 W	QB	5.63	4.79	4.43	2.95	2.75	3.94	2.22	3.01	3.28	3.79	3.38	4.05
	QE	19.24	9.38	15.76	7.85	8.57	10.39	6.61	6.71	7.61	8.90	11.16	8.66
	QC	4.05	2.68	3.72	4.07	3.47	3.88	3.80	3.79	2.48	3.27	3.05	2.80
	QN	22.27	11.90	19.24	11.44	12.78	13.79	10.38	11.77	10.40	13.49	14.16	11.40
	OBS	27	24	26	39	42	25	34	39	29	40	37	28
28 N	QS	5.20	7.46	9.17	9.33	9.39	9.45	8.41	9.09	12.37	6.62	5.92	5.18
124 W	QB	3.61	3.86	4.05	3.25	3.60	3.32	2.62	3.20	4.34	3.15	3.40	4.07
	QE	8.19	13.35	16.47	8.55	10.65	6.96	6.55	10.67	10.26	5.94	10.77	11.65
	QC	2.84	3.52	4.53	2.75	3.15	3.30	2.93	4.09	4.22	2.13	4.23	2.85
	QN	10.96	17.10	22.31	11.67	14.95	11.87	10.53	14.72	15.60	8.97	15.47	14.39
	OBS	33	20	26	31	38	37	34	31	17	45	33	29

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
29 N	QS	5.00	5.28	5.83	8.61	10.33	9.30	10.92	10.04	9.96	7.67	5.58	4.50
115 W	QB	4.13	3.38	3.19	3.91	4.28	3.50	4.03	3.75	3.92	4.25	4.29	3.94
	QE	10.39	6.37	7.87	7.92	7.03	6.38	8.02	7.11	12.28	8.85	9.67	13.12
	QC	3.91	2.11	2.78	3.60	4.32	2.86	4.38	3.08	3.52	2.75	2.42	3.65
	QN	13.95	7.81	10.93	11.24	13.17	9.66	13.55	12.58	16.94	12.85	11.80	15.85
	OBS	48	69	71	54	43	46	44	47	39	36	48	49
29 N	QS	1.26	1.58	1.75	2.13	2.10	2.04	2.25	2.22	2.18	1.69	1.30	1.15
116 W	QB	1.03	1.03	.90	.89	.81	.72	.75	.78	.86	.90	.93	1.01
	QE	2.35	2.11	2.00	1.74	1.69	1.55	1.39	1.75	2.22	2.03	2.42	2.90
	QC	.78	.76	.83	.82	.79	.77	.74	.68	.80	.74	.77	.92
	QN	3.12	2.74	2.69	2.58	2.54	2.62	2.66	2.85	3.33	2.84	3.13	3.72
	OBS	689	700	812	801	843	749	720	761	729	755	726	684
29 N	QS	2.51	3.12	3.32	3.96	4.61	3.41	4.11	4.06	4.14	3.36	2.58	2.47
117 W	QB	1.94	1.92	1.61	1.65	1.70	1.18	1.37	1.36	1.62	1.71	1.69	2.15
	QE	3.61	3.93	3.26	2.99	3.49	3.07	2.69	3.15	3.73	4.20	4.53	5.77
	QC	1.41	1.77	1.38	1.46	1.74	1.42	1.47	1.40	1.35	1.50	1.34	1.73
	QN	4.86	5.50	4.61	4.21	5.43	4.58	5.08	4.97	5.61	5.90	5.90	7.08
	OBS	182	180	245	226	169	213	185	202	202	190	188	155
29 N	QS	3.72	7.18	6.86	7.43	9.56	8.99	12.25	9.61	9.40	7.89	6.34	5.13
118 W	QB	2.76	4.11	3.22	3.06	3.95	3.00	4.28	3.34	3.85	4.22	4.48	4.23
	QE	5.22	5.81	7.30	5.56	6.23	5.43	5.64	5.97	7.13	8.06	7.41	12.35
	QC	1.88	2.04	2.68	2.19	4.16	2.36	3.18	2.49	2.53	2.01	3.90	4.19
	QN	6.96	7.91	10.65	7.44	9.46	9.60	12.67	11.86	12.41	10.89	10.60	16.41
	OBS	85	43	59	59	51	43	28	45	40	33	36	31
29 N	QS	8.69	10.64	8.05	8.15	10.19	12.01	6.87	10.20	9.99	6.58	7.07	5.85
119 W	QB	6.62	5.63	3.99	3.34	3.99	4.56	2.24	4.03	3.90	3.35	4.50	4.97
	QE	11.19	7.37	11.46	8.21	7.76	9.14	6.70	8.81	6.76	5.93	11.75	16.62
	QC	3.92	3.64	4.34	2.60	2.95	2.91	2.39	2.77	2.75	2.47	2.38	4.74
	QN	13.66	10.44	16.89	10.94	11.63	11.93	10.09	10.50	10.71	8.77	15.35	20.39
	OBS	15	17	26	27	34	29	34	24	34	46	22	20
29 N	QS	8.55	8.76	10.36	7.39	9.55	11.48	6.06	5.87	8.04	7.93	7.55	4.67
120 W	QB	7.16	5.10	5.03	2.82	3.61	4.12	2.17	2.26	3.43	4.22	4.85	3.96
	QE	13.58	9.30	13.10	10.15	5.92	9.25	6.48	4.98	5.97	12.63	6.37	9.90
	QC	3.65	3.17	5.13	4.32	2.62	4.00	2.44	2.07	2.39	5.61	3.58	2.62
	QN	17.53	12.05	16.68	16.03	9.83	14.33	7.80	8.23	9.50	17.54	9.94	11.33
	OBS	19	25	17	52	44	33	41	56	40	31	23	29
29 N	QS	4.63	7.73	8.86	8.70	9.50	7.99	6.91	8.05	7.28	7.24	5.79	5.57
121 W	QB	3.60	5.17	4.21	3.65	3.52	2.78	2.32	3.09	2.97	3.68	4.64	4.87
	QE	8.75	10.85	7.56	9.32	8.11	6.80	6.15	6.92	6.75	7.93	8.18	11.21
	QC	2.32	5.54	2.60	3.56	3.31	2.81	2.89	2.97	2.04	2.27	2.35	3.36
	QN	10.86	13.61	11.29	13.72	12.08	10.97	10.21	9.59	9.60	9.36	9.73	13.96
	OBS	44	23	31	38	45	49	51	39	36	32	34	27
29 N	QS	5.27	6.56	7.14	9.09	6.48	7.07	7.48	6.63	8.85	6.33	4.85	5.14
122 W	QB	4.48	3.94	3.43	3.60	2.30	2.60	2.75	2.55	3.72	2.93	3.20	4.38
	QE	13.49	6.42	9.47	8.84	4.39	4.38	6.27	5.99	7.67	6.60	7.28	9.55
	QC	3.25	3.62	4.14	3.56	2.06	2.21	2.95	2.65	3.36	2.54	2.09	2.60
	QN	15.90	9.70	14.03	12.17	7.32	7.70	9.30	9.16	11.22	9.71	9.13	11.93
	OBS	36	36	38	45	66	74	43	57	36	57	51	29
29 N	QS	6.75	7.92	8.02	10.21	8.48	8.56	5.82	9.13	7.62	8.36	6.49	4.88
123 W	QB	4.54	5.51	3.81	3.85	2.93	3.31	1.95	3.33	3.18	4.21	4.58	3.75
	QE	17.56	18.07	15.46	10.25	6.76	7.07	6.26	8.15	7.16	9.25	11.27	9.41
	QC	3.72	5.98	4.75	4.16	2.40	3.05	2.51	2.91	2.74	2.84	2.41	2.86
	QN	21.16	22.56	17.38	15.11	10.13	11.32	8.95	12.98	10.95	13.49	13.98	12.17
	OBS	28	18	25	25	44	57	50	42	41	34	21	24
29 N	QS	5.99	9.91	9.52	10.85	9.26	9.55	7.10	7.77	9.32	7.58	5.51	8.89
124 W	QB	4.17	5.09	4.85	4.67	3.30	3.20	2.45	3.10	3.92	3.62	3.72	7.38
	QE	8.24	12.16	20.57	12.63	5.58	8.40	5.69	7.19	11.42	10.86	9.16	22.41
	QC	3.95	4.55	5.91	4.04	2.55	3.95	2.86	3.02	3.24	2.64	3.48	6.87
	QN	11.67	17.23	28.13	15.89	11.30	13.07	9.47	10.99	14.10	13.63	12.29	28.97
	OBS	29	20	20	29	48	37	40	33	28	31	38	12

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
30 N 116 W	QS	1.76	2.27	2.44	3.19	3.12	2.70	3.14	3.03	3.12	2.39	1.96	1.71
	QB	1.43	1.47	1.28	1.33	1.21	.97	1.04	1.07	1.23	1.26	1.46	1.57
	QE	2.98	2.79	2.88	2.42	2.60	2.16	1.95	2.24	2.77	3.07	3.64	3.37
	QC	1.05	.97	1.10	1.13	1.03	.92	.96	.92	1.18	.99	1.10	1.06
	QN	3.94	3.79	3.95	3.67	3.87	3.30	3.70	3.72	4.36	4.20	4.68	4.34
	OBS	375	344	429	371	420	396	349	354	358	363	318	311
30 N 117 W	QS	1.57	2.03	2.30	2.82	2.90	2.75	2.62	2.66	2.74	2.07	1.57	1.40
	QB	1.34	1.31	1.19	1.20	1.12	.93	.86	.94	1.09	1.12	1.19	1.27
	QE	2.61	2.60	2.62	2.49	2.11	1.90	1.77	2.11	2.42	2.64	2.85	3.26
	QC	.96	1.02	.95	1.11	.97	.85	.89	.78	.96	.89	1.04	.96
	QN	3.45	3.48	3.57	3.63	3.35	3.20	3.33	3.48	3.79	3.65	3.79	4.11
	OBS	416	460	490	455	460	454	465	495	446	475	445	434
30 N 118 W	QS	2.91	3.81	4.69	5.32	5.34	5.12	4.00	4.61	5.33	4.02	3.27	2.88
	QB	2.41	2.35	2.41	2.30	2.06	1.81	1.40	1.59	2.26	2.11	2.48	2.66
	QE	6.06	4.71	4.26	4.26	4.00	3.81	3.33	4.14	4.75	3.47	5.85	6.84
	QC	2.12	1.88	1.96	1.74	1.81	1.93	1.89	1.77	2.21	1.60	1.62	2.00
	QN	8.08	6.08	6.14	5.78	6.17	6.67	5.67	7.01	7.29	5.18	7.17	8.59
	OBS	130	136	131	134	125	137	135	135	124	136	102	115
30 N 119 W	QS	4.52	6.00	7.55	8.88	13.57	7.81	9.73	10.11	8.54	5.23	5.91	4.42
	QB	3.48	3.90	4.71	3.67	4.67	2.83	3.45	4.12	3.52	2.83	4.25	4.04
	QE	9.93	8.70	9.89	5.78	9.90	4.40	3.85	11.71	7.94	6.39	9.92	14.03
	QC	3.76	2.76	2.79	3.02	4.59	3.18	2.20	4.22	3.78	2.35	2.81	4.09
	QN	13.84	10.88	13.07	10.16	14.20	6.52	8.85	10.63	12.58	9.49	12.62	17.70
	OBS	57	48	39	46	26	50	47	29	46	75	36	38
30 N 120 W	QS	4.84	4.43	6.31	6.83	6.77	7.51	8.47	6.31	8.90	5.35	6.32	3.95
	QB	4.00	2.53	2.96	2.71	2.66	2.67	2.91	2.57	3.54	2.72	5.07	3.40
	QE	11.41	5.46	5.64	8.06	6.54	5.38	5.08	10.30	6.09	7.07	10.36	10.79
	QC	2.96	2.57	4.52	3.32	2.42	2.17	3.52	3.64	2.15	2.01	4.21	2.72
	QN	14.50	7.77	10.43	11.68	9.05	7.75	10.38	14.03	10.67	9.96	13.75	13.32
	OBS	50	90	49	75	75	65	51	58	45	81	25	41
30 N 121 W	QS	4.58	5.42	8.94	5.86	6.91	7.07	5.12	4.50	8.30	6.29	6.61	4.01
	QB	3.87	3.18	4.11	2.52	2.67	2.52	1.77	1.73	2.99	3.45	4.62	3.58
	QE	9.95	6.19	7.36	6.37	4.66	5.04	3.69	3.88	6.07	8.74	5.63	14.72
	QC	3.42	2.19	3.70	2.34	2.61	3.17	1.87	1.96	3.16	2.94	2.69	2.87
	QN	13.54	7.81	11.74	8.63	7.66	8.49	6.16	6.06	11.01	12.24	7.87	16.94
	OBS	45	60	38	83	77	59	70	84	53	58	27	33
30 N 122 W	QS	4.07	6.40	7.71	8.87	7.00	6.02	6.34	6.65	7.38	6.19	5.57	5.55
	QB	3.99	3.92	3.77	3.77	2.70	2.26	2.06	2.46	2.81	3.30	3.54	4.88
	QE	8.98	10.54	8.76	9.28	5.76	6.05	5.14	6.53	8.89	9.28	7.71	21.48
	QC	3.25	3.63	3.98	3.95	2.60	2.01	2.23	2.62	3.61	3.83	3.17	5.75
	QN	11.80	13.05	12.07	12.49	9.38	7.93	7.56	9.77	13.12	13.71	11.02	27.25
	OBS	49	38	37	36	81	89	63	64	51	44	39	17
30 N 123 W	QS	4.40	7.89	8.16	8.89	6.03	6.72	6.57	8.99	7.82	8.63	5.30	3.77
	QB	3.12	4.38	4.19	3.91	2.18	2.45	2.12	3.63	3.27	4.53	3.95	3.32
	QE	14.70	9.77	12.40	10.34	4.47	6.99	5.73	6.72	7.72	13.36	7.94	10.41
	QC	3.12	4.84	4.87	3.96	2.45	2.25	2.17	2.06	2.56	3.31	2.23	3.60
	QN	17.53	13.36	17.67	15.64	6.83	9.65	8.69	9.09	10.82	15.46	9.91	13.60
	OBS	32	26	31	33	58	64	52	41	43	27	39	36
30 N 124 W	QS	4.26	6.21	8.47	8.31	5.61	5.84	8.55	8.16	8.14	5.60	4.86	5.36
	QB	3.37	4.15	4.28	3.52	1.99	2.12	2.95	2.93	3.61	2.82	3.54	4.63
	QE	11.58	9.95	7.54	9.23	6.05	4.18	6.21	6.75	6.02	9.21	9.13	14.15
	QC	3.28	3.22	3.52	3.64	2.66	1.64	3.02	2.44	3.06	2.61	2.68	4.81
	QN	14.90	12.31	11.83	12.64	8.59	6.57	10.21	10.76	10.65	12.22	11.20	18.85
	OBS	44	44	32	45	76	87	43	51	34	52	39	27
30 N 125 W	QS	4.00	5.47	8.48	8.07	7.84	7.18	7.17	8.05	8.34	6.66	4.49	4.14
	QB	3.66	3.43	4.14	3.40	2.71	2.75	2.48	2.90	4.00	3.04	2.86	3.88
	QE	12.09	11.30	11.45	8.55	9.84	5.25	6.73	7.43	8.89	9.35	10.03	11.42
	QC	3.98	4.20	4.01	2.60	4.25	2.68	3.11	3.35	3.04	3.21	2.96	3.92
	QN	15.41	14.57	15.10	10.25	12.81	8.71	8.79	10.75	11.28	13.76	12.33	14.96
	OBS	36	44	38	46	37	64	45	43	37	42	44	32

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
31 N	QS	1.43	1.84	2.12	2.67	2.64	2.44	2.62	2.62	2.65	2.07	1.60	1.36
117 W	QB	1.26	1.25	1.14	1.16	1.03	.88	.88	.93	1.09	1.13	1.23	1.35
	QE	2.19	2.37	2.39	2.11	1.82	1.59	1.68	2.16	2.08	2.13	2.65	3.24
	QC	.80	1.01	.89	.87	.80	.64	.75	.82	.75	.77	.91	1.08
	QN	2.91	3.21	3.32	3.09	2.95	2.64	3.13	3.43	3.24	3.02	3.44	4.19
	OBS	492	510	549	540	575	554	521	520	508	516	474	450
31 N	QS	1.85	2.63	2.68	3.34	3.34	3.64	3.12	3.33	3.08	2.65	1.95	1.71
118 W	QB	1.58	1.74	1.46	1.45	1.29	1.31	1.05	1.25	1.39	1.49	1.53	1.65
	QE	3.24	3.39	3.08	2.92	2.64	2.43	2.34	2.88	2.86	3.84	3.62	4.09
	QC	1.21	1.45	1.28	1.39	1.20	1.37	1.15	1.23	1.24	1.49	1.18	1.31
	QN	4.41	4.55	4.23	4.49	4.13	4.28	4.05	4.74	4.29	5.13	4.75	5.16
	OBS	291	263	328	312	303	268	256	307	336	319	279	273
31 N	QS	2.29	3.42	3.91	4.51	5.00	4.23	4.26	5.10	4.14	2.93	2.80	2.44
119 W	QB	2.01	2.19	2.23	1.97	1.94	1.55	1.51	1.95	1.87	1.62	2.20	2.29
	QE	3.92	4.31	5.70	4.77	3.34	3.20	2.25	4.05	3.22	3.18	4.90	6.54
	QC	1.41	1.49	2.07	1.83	1.38	1.42	1.68	1.65	1.33	1.24	1.52	2.09
	QN	5.06	5.39	8.10	6.52	5.39	5.15	4.85	6.64	4.99	4.32	6.29	8.23
	OBS	205	165	147	185	171	218	185	150	192	257	139	103
31 N	QS	2.92	4.21	5.69	5.35	5.68	6.73	4.93	5.59	6.57	3.73	3.85	3.67
120 W	QB	2.76	2.67	2.86	2.30	2.12	2.52	1.66	2.39	2.94	2.14	2.68	3.52
	QE	6.67	5.34	5.86	6.58	4.31	4.38	3.87	5.20	5.78	4.09	4.94	6.35
	QC	1.89	2.54	2.28	2.16	2.11	2.39	1.69	1.95	2.67	1.42	1.80	1.72
	QN	8.60	6.75	8.10	9.28	6.99	7.61	6.19	7.05	9.13	5.83	6.67	7.85
	OBS	120	101	79	108	113	82	136	91	77	170	93	60
31 N	QS	3.75	3.71	5.42	5.60	6.44	8.77	5.66	4.84	7.96	4.78	4.03	3.54
121 W	QB	3.19	2.25	2.81	2.32	2.44	3.14	2.08	1.91	3.26	2.55	2.75	3.27
	QE	8.64	4.96	6.18	5.92	4.60	5.10	4.72	4.97	7.88	6.16	6.08	7.20
	QC	2.30	1.96	3.48	2.43	2.15	2.49	2.30	2.21	4.04	2.30	2.03	2.31
	QN	10.80	6.43	9.98	9.25	6.75	8.09	7.51	6.95	13.29	8.79	8.29	9.38
	OBS	79	107	76	100	98	73	96	81	62	93	80	62
31 N	QS	3.75	5.04	5.84	7.23	6.36	7.38	6.69	5.70	7.09	4.94	3.56	3.36
122 W	QB	3.06	3.02	2.91	3.22	2.31	2.80	2.39	2.10	2.77	2.76	2.68	3.04
	QE	5.89	7.84	6.90	9.22	4.98	5.50	4.67	4.44	7.82	6.58	7.29	7.48
	QC	2.32	3.33	3.54	5.18	2.57	2.14	2.54	2.15	2.31	2.33	2.67	2.92
	QN	7.79	10.92	10.66	14.31	8.09	8.06	8.05	6.85	10.89	8.46	9.63	10.01
	OBS	62	63	68	54	77	79	76	71	63	81	69	66
31 N	QS	3.08	4.59	5.68	6.11	7.13	6.67	4.51	5.98	5.05	4.12	3.95	3.61
123 W	QB	2.78	3.09	2.78	2.58	2.87	2.57	1.53	2.24	2.20	2.45	3.15	3.11
	QE	6.11	7.22	6.84	7.67	6.03	5.16	3.81	3.98	5.80	5.88	6.29	9.61
	QC	2.39	3.04	2.48	3.00	2.92	2.28	2.09	2.26	1.84	1.91	2.08	2.89
	QN	8.18	9.51	9.65	10.46	9.70	7.88	6.53	7.33	7.74	7.23	8.33	11.97
	OBS	74	72	63	71	72	89	124	89	88	93	61	48
31 N	QS	3.02	5.01	5.01	5.29	5.05	5.29	4.86	7.56	6.58	4.94	3.83	3.00
124 W	QB	2.44	3.36	2.59	2.16	2.00	1.90	1.67	2.75	2.78	2.67	3.02	2.87
	QE	7.97	8.25	7.70	5.22	3.96	4.64	3.99	5.28	5.84	5.95	8.64	9.34
	QC	2.30	3.57	2.98	2.21	1.52	1.89	1.75	2.23	1.80	1.81	2.86	3.20
	QN	9.75	11.52	10.52	7.19	6.28	7.12	5.87	9.59	7.58	7.93	11.51	12.10
	OBS	70	60	76	115	164	130	108	66	72	79	62	60
31 N	QS	3.01	3.43	4.89	5.02	5.95	5.53	4.53	6.65	5.08	4.18	3.22	3.16
125 W	QB	2.27	1.97	2.25	2.17	2.31	1.96	1.50	2.49	2.20	2.23	2.61	2.80
	QE	6.77	7.55	5.74	6.60	6.07	4.03	4.22	5.32	6.03	7.14	7.94	11.24
	QC	2.78	3.03	2.23	2.96	2.10	2.00	1.78	2.28	2.04	3.01	2.41	4.46
	QN	9.20	10.46	8.82	8.95	9.02	6.63	6.57	8.65	7.32	9.84	10.01	15.37
	OBS	82	81	87	97	99	116	111	84	78	102	79	59
31 N	QS	2.74	3.31	4.35	5.47	5.45	4.93	3.59	5.69	4.82	3.59	2.87	2.76
126 W	QB	2.21	2.24	2.19	2.46	2.10	1.71	1.27	2.14	2.08	1.80	2.17	2.35
	QE	5.59	7.82	5.44	5.72	5.47	3.87	4.88	5.03	4.47	5.06	9.00	9.19
	QC	2.77	3.25	2.49	2.54	2.01	1.73	1.91	1.83	1.60	1.62	2.45	2.80
	QN	7.81	10.87	7.98	8.38	8.49	6.12	6.90	7.30	6.42	6.70	10.30	11.25
	OBS	95	92	102	94	112	128	113	109	99	126	98	77

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
32 N	QS	1.19	1.74	2.06	2.52	2.56	2.48	2.67	2.25	2.45	1.89	1.46	1.27
117 W	QB	1.08	1.21	1.13	1.11	1.03	.89	.90	.82	1.04	1.09	1.19	1.29
	QE	1.79	1.97	2.11	2.05	1.51	1.22	1.43	1.36	1.74	2.15	2.13	2.93
	QC	.68	.82	.76	.89	.65	.57	.62	.55	.77	.75	.70	1.13
	QN	2.38	2.71	2.99	3.13	2.61	2.33	2.56	2.34	2.84	3.01	2.74	3.90
	OBS	667	573	610	590	660	673	585	761	535	595	506	445
32 N	QS	.81	1.21	1.28	1.60	1.60	1.63	1.67	1.54	1.44	1.21	.93	.98
118 W	QB	.76	.83	.68	.72	.63	.58	.58	.57	.63	.73	.73	1.02
	QE	1.38	1.40	1.34	1.47	1.14	1.10	.99	1.26	1.13	1.87	1.70	2.51
	QC	.50	.56	.51	.60	.49	.46	.46	.44	.48	.55	.59	.80
	QN	1.85	1.91	1.83	2.18	1.82	1.76	1.82	1.93	1.77	2.35	2.25	3.27
	OBS	1441	1172	1543	1432	1556	1305	1366	1546	1586	1431	1248	780
32 N	QS	1.13	1.62	1.73	2.29	2.51	2.67	2.21	2.09	1.95	1.45	1.27	1.11
119 W	QB	1.04	1.09	.96	1.01	1.00	1.00	.79	.81	.88	.85	1.06	1.13
	QE	1.91	2.56	2.05	2.13	1.91	1.97	1.54	1.88	1.71	1.73	2.58	3.01
	QC	.75	.89	.80	.91	.83	.99	.78	.79	.75	.62	.79	.96
	QN	2.60	3.29	2.80	3.12	2.93	3.19	2.69	2.80	2.57	2.29	3.28	3.90
	OBS	787	658	824	731	675	615	709	767	873	1021	668	570
32 N	QS	1.79	2.76	3.00	3.48	4.02	4.75	3.47	3.24	2.96	2.67	2.14	1.95
120 W	QB	1.68	1.82	1.54	1.48	1.58	1.75	1.27	1.34	1.40	1.52	1.68	1.94
	QE	3.60	4.34	3.14	4.04	3.28	3.56	2.02	3.26	2.54	3.57	3.44	5.68
	QC	1.19	1.65	1.18	1.72	1.57	1.65	1.17	1.42	1.07	1.27	1.30	2.11
	QN	4.68	5.74	4.62	5.84	5.17	5.77	3.75	4.93	3.63	4.76	4.46	7.68
	OBS	278	224	304	318	281	215	359	277	377	354	262	191
32 N	QS	2.41	3.03	3.71	4.31	4.94	5.51	4.55	4.36	4.51	3.45	2.52	2.44
121 W	QB	2.17	2.08	1.95	1.90	1.94	2.12	1.71	1.80	2.04	1.96	2.04	2.37
	QE	4.66	4.50	5.20	4.56	3.86	4.26	3.52	3.49	4.75	4.26	5.27	5.07
	QC	1.86	2.03	2.18	1.82	1.71	2.04	1.62	1.49	1.93	1.80	1.82	1.95
	QN	6.16	6.20	7.37	6.43	5.93	6.53	5.66	5.18	6.89	6.11	7.02	6.79
	OBS	165	180	178	186	195	150	184	175	176	199	162	128
32 N	QS	2.49	3.10	3.71	4.36	5.31	5.48	4.58	5.36	5.10	3.34	2.58	2.55
122 W	QB	2.15	2.05	1.88	1.89	2.02	2.05	1.68	2.23	2.31	1.96	2.08	2.49
	QE	5.44	5.88	5.43	4.48	4.92	4.66	3.99	4.72	5.16	4.27	5.46	6.42
	QC	2.42	2.49	2.16	2.04	2.14	2.08	2.02	2.18	2.02	1.41	1.97	2.72
	QN	7.56	8.11	7.38	5.94	7.24	7.19	6.64	7.09	7.19	5.70	7.27	8.79
	OBS	131	152	161	154	138	132	141	109	126	198	139	112
32 N	QS	2.13	3.07	3.51	4.65	5.57	5.46	4.74	5.19	5.18	3.46	2.62	2.38
123 W	QB	1.79	1.95	1.77	1.94	2.18	1.97	1.73	2.02	2.20	2.02	2.13	2.32
	QE	4.20	5.72	5.51	5.12	4.78	3.95	4.10	4.35	5.07	5.75	5.90	7.71
	QC	1.69	2.18	2.07	2.25	2.06	1.76	1.87	1.52	1.95	1.87	2.11	3.14
	QN	5.84	7.62	7.47	7.76	7.27	6.35	6.68	6.70	7.73	7.36	7.77	10.63
	OBS	180	139	153	131	126	121	125	127	118	154	145	111
32 N	QS	1.39	2.21	2.67	3.71	3.32	3.35	3.38	2.66	2.75	2.13	1.74	1.44
124 W	QB	1.18	1.33	1.33	1.45	1.23	1.23	1.21	.99	1.15	1.22	1.35	1.41
	QE	3.07	3.56	3.18	3.61	3.23	3.21	2.64	2.30	3.20	3.16	3.00	3.62
	QC	.97	1.31	1.18	1.50	1.25	1.54	1.21	1.06	1.33	1.11	1.03	1.25
	QN	3.95	4.45	4.37	5.67	5.08	4.71	4.25	3.54	4.56	4.16	3.92	4.61
	OBS	382	290	349	239	305	312	359	388	363	415	326	331
32 N	QS	1.93	2.89	3.37	3.95	4.52	3.97	4.08	3.80	4.29	2.76	2.05	1.62
125 W	QB	1.68	1.77	1.65	1.69	1.68	1.36	1.43	1.40	1.76	1.55	1.57	1.59
	QE	4.01	5.31	5.37	4.34	4.28	3.77	3.29	3.02	4.34	4.32	4.23	5.73
	QC	1.58	2.09	2.11	2.14	1.59	1.60	1.55	1.45	1.67	1.65	1.50	1.84
	QN	5.42	6.89	7.35	6.65	6.58	5.75	5.44	4.97	6.07	5.96	5.43	7.36
	OBS	189	161	176	178	197	199	188	187	160	198	190	198
32 N	QS	1.92	2.95	2.81	3.56	3.99	4.49	3.47	3.68	3.65	2.69	1.88	1.64
126 W	QB	1.61	1.89	1.32	1.51	1.51	1.64	1.18	1.31	1.50	1.46	1.43	1.53
	QE	4.41	6.04	3.98	4.02	3.95	4.33	3.69	3.03	4.63	4.52	4.51	6.13
	QC	1.99	2.10	1.68	1.70	1.85	1.94	1.63	1.33	1.74	1.43	1.39	2.12
	QN	6.23	7.73	5.62	5.53	6.11	6.76	5.52	4.90	6.73	5.82	5.66	8.06
	OBS	206	160	226	223	220	208	196	217	191	233	224	193

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
33 N	QS	.60	.85	1.00	1.28	1.39	1.43	1.49	1.26	1.21	.91	.65	.63
118 W	QB	.59	.62	.55	.58	.56	.51	.52	.47	.53	.54	.56	.70
	QE	1.13	1.19	1.16	1.14	.90	.81	.81	.88	.87	1.06	1.33	1.82
	QC	.40	.37	.42	.44	.36	.32	.36	.32	.36	.36	.40	.60
	QN	1.46	1.47	1.59	1.61	1.44	1.32	1.45	1.38	1.32	1.38	1.66	2.36
	OBS	2385	2257	2504	2329	2271	2262	2150	2400	2259	2406	2344	1622
33 N	QS	1.00	1.40	1.54	2.17	2.25	2.44	2.50	1.93	1.87	1.36	1.02	.90
119 W	QB	.95	.99	.84	1.01	.90	.91	.89	.74	.85	.80	.85	.99
	QE	2.34	2.20	1.96	2.07	1.57	1.67	1.82	1.42	1.59	1.67	1.97	2.56
	QC	.73	.76	.77	.85	.73	.81	.81	.60	.66	.61	.70	.83
	QN	2.70	2.81	2.79	2.89	2.53	2.68	3.05	2.26	2.26	2.19	2.54	3.30
	OBS	860	807	1054	854	948	835	727	1061	927	1146	1023	762
33 N	QS	1.27	2.10	2.13	2.67	3.08	3.02	3.09	2.93	2.74	2.25	1.48	1.28
120 W	QB	1.23	1.41	1.12	1.23	1.23	1.14	1.13	1.20	1.29	1.33	1.21	1.38
	QE	2.69	3.06	2.37	2.73	2.31	1.97	2.36	3.10	2.38	2.91	2.74	3.79
	QC	1.01	1.16	1.05	1.35	1.18	1.16	1.20	1.44	1.12	1.07	.97	1.48
	QN	3.64	4.05	3.38	4.06	3.74	3.44	4.10	4.75	3.65	3.87	3.50	5.04
	OBS	495	399	586	534	527	553	453	457	476	447	462	406
33 N	QS	1.85	2.83	3.31	4.15	4.36	4.35	4.37	3.95	3.71	3.80	2.20	1.86
121 W	QB	1.76	1.94	1.74	1.91	1.73	1.64	1.59	1.60	1.69	2.22	1.84	1.94
	QE	3.53	4.08	3.80	5.04	3.59	3.22	3.44	3.74	3.77	4.39	3.95	6.05
	QC	1.58	1.93	1.82	2.28	1.76	1.64	2.02	1.83	1.82	1.61	1.46	2.35
	QN	4.89	5.82	5.60	7.28	5.38	5.27	6.22	6.28	5.79	6.23	5.14	8.20
	OBS	260	194	229	216	229	248	196	195	237	158	222	190
33 N	QS	1.92	2.85	3.20	3.76	4.56	4.74	4.37	4.43	3.70	3.25	2.14	1.75
122 W	QB	1.85	1.87	1.66	1.74	1.78	1.67	1.68	1.77	1.76	1.98	1.73	1.81
	QE	3.79	4.46	4.15	4.10	3.62	3.68	3.83	3.63	3.73	4.98	3.82	4.43
	QC	1.63	1.96	1.85	1.84	1.76	1.89	2.05	1.44	1.39	1.59	1.57	1.75
	QN	5.49	5.91	5.83	5.94	5.78	5.89	6.02	5.53	5.30	6.39	5.20	5.88
	OBS	225	209	240	241	212	196	186	190	210	200	229	213
33 N	QS	1.88	2.59	3.06	3.20	3.60	4.45	3.54	4.25	3.46	3.04	2.21	1.68
123 W	QB	1.76	1.72	1.59	1.34	1.40	1.55	1.30	1.69	1.57	1.78	1.82	1.73
	QE	4.36	4.03	3.69	3.01	3.27	3.71	2.63	2.83	3.72	3.69	5.20	5.31
	QC	1.90	1.60	1.84	1.26	1.37	1.78	1.42	1.47	1.44	1.47	1.88	2.31
	QN	6.15	5.25	5.52	4.19	5.03	5.73	4.37	4.48	5.38	4.99	6.79	7.30
	OBS	233	224	248	349	296	231	280	203	227	204	198	220
33 N	QS	1.70	2.67	2.94	3.38	3.57	4.63	4.12	3.28	3.86	2.72	1.86	1.65
124 W	QB	1.55	1.83	1.55	1.48	1.34	1.69	1.47	1.23	1.65	1.54	1.54	1.65
	QE	4.00	4.57	3.28	3.97	3.73	4.03	3.57	2.88	3.48	3.78	4.83	4.31
	QC	1.57	1.92	1.48	1.94	1.55	1.85	1.67	1.38	1.18	1.43	1.69	1.84
	QN	5.47	6.04	4.55	5.72	5.70	5.95	5.31	4.48	5.10	5.10	6.40	5.84
	OBS	248	189	266	239	245	211	217	239	201	254	245	224
33 N	QS	1.65	2.45	3.24	3.89	4.05	4.16	3.27	3.69	4.12	2.85	1.91	1.52
125 W	QB	1.36	1.58	1.61	1.65	1.53	1.45	1.10	1.44	1.80	1.56	1.60	1.50
	QE	3.88	4.09	3.68	4.59	3.64	3.97	3.26	3.11	4.80	5.10	4.39	4.72
	QC	1.98	1.94	1.64	2.03	1.86	1.74	1.53	1.49	1.53	1.74	1.65	1.86
	QN	5.62	5.66	5.10	6.44	6.00	5.98	4.92	4.50	6.41	6.73	5.54	6.17
	OBS	228	212	231	204	226	212	204	214	175	212	216	234
33 N	QS	2.18	3.35	3.59	4.57	5.10	5.27	5.15	5.16	4.39	3.27	2.35	2.02
126 W	QB	1.85	2.17	1.88	2.02	1.99	1.85	1.86	2.03	1.81	1.81	1.90	2.02
	QE	5.54	5.81	5.34	5.14	4.17	4.61	4.79	4.26	5.56	5.58	5.08	5.76
	QC	2.28	2.41	2.29	2.30	1.78	1.96	2.12	2.22	2.12	1.75	1.85	2.40
	QN	7.71	7.75	7.30	7.45	6.62	6.63	7.96	6.50	7.26	7.36	6.79	7.90
	OBS	155	107	158	136	139	118	139	133	135	144	144	138
33 N	QS	2.72	3.29	4.03	5.32	5.82	5.84	5.09	6.07	5.14	3.43	2.65	2.13
127 W	QB	2.31	2.16	2.00	2.21	2.12	1.97	1.71	2.28	2.24	1.83	2.19	2.16
	QE	5.98	5.48	4.92	6.09	4.55	5.16	5.65	4.47	7.74	6.99	6.13	7.57
	QC	2.72	3.00	2.23	2.44	2.30	2.15	2.40	1.98	2.88	2.07	2.10	2.71
	QN	8.33	7.85	7.30	8.37	7.66	7.73	8.15	7.05	10.50	9.03	7.80	10.16
	OBS	100	114	132	119	114	103	127	101	96	135	111	117

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
34 N	QS	1.87	2.48	2.92	3.78	4.32	4.53	4.15	3.96	3.46	2.81	1.64	1.42
119 W	QB	1.82	1.83	1.64	1.70	1.80	1.74	1.55	1.58	1.60	1.69	1.46	1.64
	QE	3.82	3.64	3.57	2.97	2.90	2.52	2.35	2.33	2.83	2.66	3.69	4.14
	QC	1.48	1.09	1.23	1.37	1.53	1.11	.96	1.02	1.15	1.14	1.09	1.40
	QN	4.89	4.04	4.57	4.38	4.66	4.32	3.94	3.73	3.89	3.27	4.64	4.74
	OBS	234	268	297	249	250	267	313	278	275	262	338	276
34 N	QS	1.86	2.31	2.79	3.27	4.18	4.15	3.69	3.85	3.39	2.58	1.70	1.57
120 W	QB	1.84	1.60	1.51	1.53	1.78	1.63	1.35	1.52	1.66	1.51	1.56	1.78
	QE	3.38	3.28	3.04	3.06	3.63	3.26	2.37	3.46	3.30	2.86	3.74	4.16
	QC	1.30	1.39	1.58	1.56	2.00	1.81	1.24	1.91	1.40	1.21	1.51	1.63
	QN	4.63	4.42	4.49	4.64	5.67	5.19	3.99	5.74	4.70	4.15	4.97	5.54
	OBS	246	298	312	322	261	324	403	307	300	310	315	226
34 N	QS	1.59	2.27	2.83	3.52	4.16	3.94	3.68	3.55	3.25	2.64	1.68	1.42
121 W	QB	1.55	1.64	1.57	1.58	1.68	1.52	1.39	1.45	1.60	1.57	1.47	1.61
	QE	3.03	2.76	3.28	3.51	2.94	2.87	3.13	3.23	3.25	2.96	3.21	3.44
	QC	1.37	1.28	1.62	1.82	1.67	1.69	1.86	1.63	1.60	1.27	1.33	1.23
	QN	4.15	3.86	4.97	5.25	4.80	4.87	5.45	5.06	4.97	4.29	4.20	4.48
	OBS	304	307	313	311	279	363	343	334	325	304	334	299
34 N	QS	2.16	3.07	3.97	5.08	5.75	5.92	4.82	5.78	4.85	3.76	2.20	2.08
122 W	QB	2.21	2.19	2.13	2.20	2.28	2.27	1.79	2.33	2.32	2.40	2.05	2.23
	QE	4.18	4.89	3.96	4.84	4.59	3.70	3.40	4.64	4.25	5.76	4.94	4.11
	QC	1.83	2.15	1.96	2.55	2.33	2.06	1.91	2.28	2.12	2.16	2.06	1.83
	QN	5.93	6.51	5.67	7.57	7.03	6.50	5.96	8.01	6.69	7.71	6.26	5.76
	OBS	150	150	152	145	145	159	164	137	140	131	166	143
34 N	QS	2.28	3.21	4.54	5.99	6.17	6.44	6.25	6.07	5.78	3.71	2.61	2.24
123 W	QB	2.25	2.14	2.42	2.68	2.39	2.44	2.26	2.50	2.56	2.33	2.35	2.50
	QE	4.69	5.83	5.25	6.41	5.29	4.51	3.55	5.48	5.49	5.23	6.60	5.65
	QC	2.17	2.77	2.65	2.94	2.96	2.72	2.13	2.55	2.25	2.46	2.88	2.50
	QN	6.72	7.82	7.58	8.93	8.22	8.48	6.86	8.68	8.04	7.37	8.93	7.93
	OBS	128	133	128	97	105	132	122	97	104	139	118	112
34 N	QS	2.75	3.41	4.43	5.32	6.89	7.27	7.17	7.01	5.51	3.52	3.03	2.27
124 W	QB	2.54	2.20	2.28	2.27	2.55	2.76	2.57	2.71	2.53	2.13	2.56	2.37
	QE	6.24	5.24	4.75	5.45	6.66	4.95	5.33	6.13	6.47	4.36	6.95	5.63
	QC	2.46	2.51	2.50	2.51	3.77	3.10	2.89	3.17	2.24	1.79	2.30	2.99
	QN	8.53	7.09	7.32	7.84	10.72	8.47	8.99	10.17	8.44	6.01	9.04	8.45
	OBS	107	124	114	115	82	98	86	82	101	144	99	123
34 N	QS	2.40	3.43	4.59	4.95	6.33	7.72	6.77	6.45	5.22	3.67	2.94	2.17
125 W	QB	2.15	2.53	2.34	2.11	2.37	2.85	2.36	2.43	2.44	2.13	2.33	2.28
	QE	4.10	6.40	5.39	6.52	5.24	6.27	6.85	4.02	5.00	6.21	4.96	6.78
	QC	2.47	2.75	2.81	2.83	3.25	2.51	2.79	2.44	1.80	2.13	1.94	2.76
	QN	6.37	8.44	8.34	9.31	9.17	9.56	9.73	7.43	6.70	8.08	6.70	9.18
	OBS	118	99	120	120	86	92	94	94	115	130	108	107
34 N	QS	2.62	3.14	4.56	5.25	5.60	6.67	5.31	8.48	5.21	3.57	2.67	1.92
126 W	QB	2.42	2.06	2.22	2.23	2.11	2.46	1.83	3.27	2.06	2.23	2.26	1.98
	QE	5.23	7.58	4.86	7.93	6.22	5.61	4.46	5.98	5.61	7.22	7.51	5.42
	QC	2.52	3.13	2.39	3.20	3.38	2.64	2.25	2.63	2.06	2.47	2.51	2.43
	QN	7.38	10.02	7.51	10.56	10.15	8.89	7.28	10.00	8.01	9.79	9.74	7.64
	OBS	103	129	103	117	107	90	93	61	95	103	100	124
34 N	QS	2.43	3.69	4.40	4.91	6.45	6.36	7.04	7.84	5.96	4.13	2.79	1.99
127 W	QB	2.17	2.52	2.12	2.03	2.34	2.23	2.46	2.95	2.61	2.49	2.22	2.11
	QE	5.66	6.25	5.17	5.57	5.84	5.69	5.69	5.06	6.23	5.71	7.20	5.51
	QC	2.85	2.47	2.37	2.51	3.56	2.96	1.92	2.32	2.03	1.99	2.55	2.42
	QN	9.35	8.09	7.35	7.88	10.03	9.11	8.74	8.52	8.40	7.37	9.54	7.62
	OBS	114	99	114	116	81	98	84	61	84	93	102	125
34 N	QS	2.14	3.13	4.35	5.47	5.21	5.85	5.86	6.23	5.49	3.92	2.71	1.74
128 W	QB	1.90	2.16	2.14	2.34	1.87	2.05	1.85	2.29	2.41	2.30	2.32	1.80
	QE	6.21	6.38	6.52	6.53	4.85	6.12	4.45	5.09	6.60	7.34	7.73	6.04
	QC	2.69	2.71	2.18	2.65	1.87	2.68	2.09	2.25	2.24	2.52	2.99	2.18
	QN	8.75	8.50	8.01	8.65	7.45	9.55	7.48	7.95	9.24	9.77	10.58	7.98
	OBS	137	116	118	102	131	97	91	85	84	98	105	129

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
35 N	QS	1.85	2.66	3.08	3.75	4.66	4.39	4.45	4.50	3.98	2.50	1.91	1.63
121 W	QB	1.92	2.00	1.73	1.68	1.97	1.69	1.70	1.89	1.94	1.54	1.76	2.05
	QE	2.87	3.68	3.83	2.95	3.28	2.82	2.98	3.11	3.10	3.18	3.14	4.19
	QC	1.31	1.57	1.78	1.68	2.19	1.80	1.83	1.87	1.68	1.35	1.30	1.77
	QN	3.99	5.05	5.61	4.82	5.71	5.18	5.57	5.17	5.18	4.50	4.37	5.77
	OBS	220	220	268	279	217	296	264	232	241	336	255	201
35 N	QS	2.34	3.18	3.82	4.06	4.85	4.95	4.45	4.40	4.07	3.09	2.02	2.23
122 W	QB	2.47	2.31	2.11	1.84	1.98	1.89	1.70	1.84	2.05	1.86	1.86	2.72
	QE	5.08	4.76	4.34	4.01	3.36	2.73	2.88	2.94	3.60	3.69	3.06	5.70
	QC	2.08	2.05	1.67	1.79	2.06	1.67	1.81	1.79	1.80	1.81	1.42	2.39
	QN	6.88	6.62	5.97	5.69	5.69	5.10	5.51	5.23	5.26	5.43	4.25	8.01
	OBS	127	152	187	203	198	216	219	226	200	209	208	113
35 N	QS	2.29	3.53	4.60	4.67	5.89	5.69	5.86	4.93	4.57	4.32	2.49	2.49
123 W	QB	2.38	2.57	2.57	1.99	2.35	2.21	2.15	1.99	2.20	2.65	2.25	2.80
	QE	5.58	5.75	5.08	4.63	5.21	3.97	4.55	3.37	3.44	4.56	5.55	7.52
	QC	2.03	2.98	2.46	2.15	2.67	2.32	2.34	2.04	1.65	1.84	2.29	2.75
	QN	7.24	8.10	7.29	6.74	8.01	6.28	8.05	5.84	5.21	6.81	7.69	10.01
	OBS	110	103	108	148	119	155	161	164	149	113	127	86
35 N	QS	2.59	3.40	5.12	5.54	5.61	6.22	5.68	5.36	5.05	3.73	2.73	2.13
124 W	QB	2.57	2.45	2.69	2.52	2.17	2.33	2.08	2.13	2.45	2.15	2.37	2.49
	QE	5.67	5.60	6.06	6.15	4.69	4.09	3.53	3.82	4.49	3.92	4.90	7.83
	QC	3.11	2.82	2.97	2.53	2.18	2.30	1.96	2.03	2.03	1.55	1.99	3.00
	QN	8.63	7.89	8.70	8.52	7.53	6.79	5.83	6.39	6.72	5.74	6.86	10.87
	OBS	86	102	99	102	139	136	140	142	122	143	120	99
35 N	QS	2.66	3.83	4.77	5.73	6.20	5.88	6.05	5.56	5.21	4.31	2.73	2.19
125 W	QB	2.64	2.73	2.38	2.49	2.43	2.10	2.24	2.19	2.40	2.54	2.41	2.45
	QE	6.00	7.07	4.74	5.95	5.03	5.04	4.65	4.84	5.49	6.70	6.59	8.66
	QC	3.03	3.29	2.20	2.92	2.89	2.68	2.70	2.46	2.87	2.05	2.71	3.32
	QN	8.76	10.16	6.83	9.10	8.44	7.95	8.64	8.23	8.55	8.21	9.19	11.40
	OBS	91	86	107	95	98	127	116	127	116	93	101	80
35 N	QS	2.46	3.33	5.12	5.29	6.50	7.18	6.11	6.26	5.37	4.33	2.90	2.00
126 W	QB	2.36	2.34	2.67	2.39	2.50	2.51	2.12	2.26	2.46	2.55	2.55	2.23
	QE	6.33	6.35	5.77	7.92	5.33	6.11	6.97	6.05	5.64	5.02	7.10	6.76
	QC	3.23	3.01	2.74	3.66	2.55	2.97	2.57	2.28	2.59	1.81	2.58	2.73
	QN	9.31	8.78	8.86	11.01	8.06	9.57	10.22	9.33	7.93	6.68	9.68	9.02
	OBS	99	90	91	109	91	84	91	99	91	99	90	101
35 N	QS	1.86	3.19	4.05	5.41	5.97	6.50	6.59	6.05	6.91	3.99	2.80	1.74
127 W	QB	1.98	2.15	2.09	2.34	2.13	2.37	2.23	2.39	2.98	2.26	2.35	1.98
	QE	6.67	5.05	5.31	6.15	5.30	5.53	5.37	5.62	6.67	7.59	7.93	8.56
	QC	2.85	2.25	2.65	3.55	2.67	2.37	2.42	2.51	2.95	2.65	3.13	3.47
	QN	9.19	6.89	7.94	9.43	8.63	8.38	9.05	8.41	10.03	9.43	11.05	11.66
	OBS	104	111	116	100	97	100	80	98	67	102	97	110
35 N	QS	1.41	2.05	2.77	4.01	4.34	4.89	4.05	3.68	3.62	2.73	1.70	1.29
128 W	QB	1.44	1.36	1.45	1.69	1.64	1.72	1.40	1.41	1.60	1.53	1.48	1.45
	QE	4.98	4.40	3.84	4.51	3.65	4.37	3.29	3.07	5.63	3.96	4.06	4.44
	QC	2.18	2.07	1.86	2.28	1.85	2.14	1.74	1.51	1.71	1.45	1.58	1.99
	QN	7.03	5.17	5.62	6.75	5.73	6.86	5.76	4.71	7.01	5.25	5.63	6.26
	OBS	249	229	251	175	187	155	201	219	181	214	242	236
35 N	QS	1.31	2.03	2.48	3.09	3.55	3.86	3.55	3.75	3.25	2.35	1.64	1.16
129 W	QB	1.29	1.42	1.27	1.36	1.29	1.37	1.21	1.37	1.44	1.33	1.41	1.30
	QE	4.08	4.34	3.18	4.33	3.28	3.64	3.49	3.10	4.43	4.81	4.58	4.35
	QC	1.68	2.00	1.52	1.89	1.37	1.51	1.47	1.26	1.44	1.55	1.61	1.65
	QN	5.67	6.13	4.67	6.02	5.21	5.42	5.46	4.63	6.04	6.24	6.17	5.84
	OBS	294	278	335	255	258	249	237	230	227	261	261	289
35 N	QS	1.05	1.68	2.18	2.69	2.96	3.24	2.98	3.07	2.55	1.76	1.27	.94
130 W	QB	1.03	1.17	1.12	1.19	1.12	1.12	.99	1.10	1.10	1.02	1.08	1.06
	QE	3.79	3.56	2.90	3.42	2.78	2.83	2.85	2.78	3.42	3.27	3.79	3.41
	QC	1.53	1.56	1.37	1.52	1.36	1.22	.98	1.05	1.08	1.02	1.39	1.36
	QN	5.22	4.89	4.24	4.93	4.34	4.44	4.34	4.33	4.55	4.21	5.05	4.65
	OBS	442	385	425	347	384	347	363	356	306	427	413	412

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
36 N	QS	1.62	2.41	2.88	3.31	4.01	3.72	3.65	4.10	3.30	2.71	1.77	1.63
122 W	QB	1.81	1.83	1.57	1.52	1.66	1.41	1.40	1.76	1.66	1.81	1.74	2.05
	QE	2.95	3.54	3.30	2.62	3.09	2.85	2.29	2.82	3.05	3.13	3.79	4.54
	QC	1.42	1.71	1.65	1.34	1.75	1.69	1.44	1.63	1.48	1.49	1.47	1.89
	QN	4.02	4.89	5.17	4.03	4.94	4.86	4.33	4.70	4.69	4.54	5.18	6.26
	OBS	268	260	322	355	298	411	422	277	303	264	272	196
36 N	QS	2.47	2.75	4.23	4.30	4.90	3.89	4.03	4.15	3.42	3.10	2.52	2.31
123 W	QB	2.75	2.08	2.33	1.93	1.95	1.48	1.56	1.79	1.71	2.10	2.18	3.30
	QE	5.96	4.71	5.52	4.06	3.60	2.40	2.53	2.66	3.01	3.93	4.68	12.28
	QC	2.33	1.92	2.40	1.74	1.78	1.46	1.58	1.46	1.37	1.77	1.90	4.51
	QN	8.18	6.36	7.28	5.71	5.94	4.12	4.45	4.74	4.70	5.51	6.34	17.07
	OBS	106	146	143	191	196	332	331	273	274	190	145	86
36 N	QS	2.79	3.23	5.60	5.37	5.89	5.86	5.67	5.39	5.12	3.87	2.80	2.28
124 W	QB	3.10	2.44	2.35	2.35	2.25	2.15	2.20	2.12	2.42	2.65	2.54	2.76
	QE	6.33	5.26	4.80	4.77	4.45	4.21	3.90	3.02	4.82	6.77	4.81	7.07
	QC	3.59	2.08	2.52	1.94	2.89	2.52	1.90	1.61	2.27	2.42	1.89	2.85
	QN	9.82	5.66	6.82	6.50	7.79	7.64	6.15	5.33	7.21	8.83	6.26	9.57
	OBS	78	99	76	130	136	148	157	157	129	111	110	92
36 N	QS	2.05	3.73	4.20	4.87	4.98	5.92	5.33	5.14	4.75	3.73	2.39	1.83
125 W	QB	2.23	2.84	2.19	2.23	1.93	2.20	2.02	2.02	2.24	2.40	2.38	2.23
	QE	5.05	7.62	4.76	5.61	4.84	3.81	3.68	4.47	4.17	5.03	6.54	6.00
	QC	3.25	3.65	2.22	2.69	2.60	2.20	2.00	2.31	1.73	1.90	2.48	2.64
	QN	8.96	11.04	7.09	8.29	7.45	6.01	6.03	6.76	6.27	6.49	8.83	8.54
	OBS	125	98	134	139	164	144	157	167	134	122	134	129
36 N	QS	1.41	1.98	2.63	3.58	3.96	4.73	4.34	4.09	3.43	2.68	1.43	1.25
126 W	QB	1.43	1.45	1.39	1.63	1.50	1.76	1.58	1.62	1.63	1.58	1.36	1.53
	QE	3.46	3.65	3.58	3.55	3.08	3.56	3.20	2.86	4.31	4.27	3.64	4.41
	QC	1.76	1.77	1.75	1.77	1.60	1.85	1.66	1.58	1.78	1.71	1.50	1.79
	QN	5.04	5.20	5.17	5.19	5.08	5.70	5.43	4.75	6.12	5.78	4.99	6.04
	OBS	292	264	296	244	252	217	249	254	231	259	342	270
36 N	QS	.91	1.39	1.90	2.47	2.66	2.99	2.92	2.72	2.38	1.73	1.16	.82
127 W	QB	.94	1.04	1.00	1.09	1.00	1.07	1.03	1.05	1.08	1.05	1.09	.98
	QE	2.68	2.81	2.47	2.75	2.39	2.52	2.40	2.34	2.79	3.14	3.39	3.14
	QC	1.28	1.45	1.26	1.30	1.16	1.15	1.13	.97	1.05	1.10	1.39	1.27
	QN	3.85	4.07	3.60	4.01	3.79	3.84	3.98	3.54	3.86	4.12	4.68	4.31
	OBS	503	509	543	486	518	482	456	556	494	507	492	540
36 N	QS	.84	1.31	1.72	2.32	2.65	2.85	2.47	2.31	2.06	1.54	.94	.76
128 W	QB	.85	.98	.91	.98	.99	1.02	.84	.87	.94	.94	.81	.90
	QE	2.44	2.47	2.37	2.59	2.31	2.51	2.09	2.00	2.42	2.88	2.76	2.69
	QC	1.06	1.21	1.17	1.26	1.13	1.14	.95	.82	.85	1.01	.92	1.02
	QN	3.42	3.56	3.44	3.90	3.47	3.91	3.44	3.10	3.41	3.80	3.59	3.62
	OBS	586	592	651	563	531	558	580	612	615	601	753	650
36 N	QS	1.14	1.60	1.85	2.29	2.81	2.89	2.63	2.60	2.30	1.72	1.22	.86
129 W	QB	1.13	1.15	.99	1.03	1.07	1.00	.90	.93	1.00	1.05	1.07	1.01
	QE	3.26	3.30	2.68	2.80	2.53	2.36	2.53	2.44	2.62	3.19	3.56	3.49
	QC	1.50	1.58	1.31	1.31	1.19	.99	1.01	.97	.88	1.06	1.33	1.45
	QN	4.62	4.66	3.91	4.01	4.09	3.57	3.82	3.79	3.60	4.16	4.84	4.84
	OBS	393	394	519	484	469	450	444	473	482	455	445	456
36 N	QS	1.35	2.08	2.44	3.29	4.16	4.28	4.11	4.14	3.20	2.26	1.37	1.17
130 W	QB	1.44	1.51	1.24	1.43	1.65	1.45	1.39	1.55	1.37	1.27	1.17	1.38
	QE	4.65	4.18	3.61	3.56	3.45	3.67	3.69	4.11	4.74	4.03	4.26	5.08
	QC	2.31	1.95	1.70	1.81	1.74	1.58	1.57	1.46	1.67	1.39	1.61	2.12
	QN	6.91	5.87	5.19	5.36	5.48	5.66	6.01	6.27	6.31	5.24	5.75	7.11
	OBS	219	233	270	242	211	204	186	183	220	245	309	234
36 N	QS	1.63	2.33	3.20	3.81	4.85	4.57	6.21	5.09	3.91	2.97	1.72	1.25
131 W	QB	1.68	1.64	1.60	1.74	1.87	1.60	2.04	1.83	1.79	1.74	1.48	1.49
	QE	5.65	5.12	4.52	4.78	4.66	4.33	3.74	5.53	5.73	5.08	5.84	5.69
	QC	2.44	2.28	2.11	2.10	1.90	1.82	1.78	2.03	1.98	1.75	2.27	2.35
	QN	7.73	7.02	6.59	6.73	7.08	6.26	7.10	8.08	7.64	6.69	7.79	7.92
	OBS	151	173	193	181	151	151	104	123	134	171	191	171

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
37 N	QS	2.25	3.36	5.35	4.88	5.83	5.92	5.27	6.68	5.11	3.96	2.72	2.23
122 W	QB	2.67	2.57	2.75	2.20	2.45	2.32	2.03	2.93	2.59	2.62	2.82	3.06
	QE	4.18	5.02	4.48	3.57	3.52	3.01	2.58	3.24	4.50	4.26	5.03	6.69
	QC	2.20	2.46	2.49	2.04	1.83	2.02	1.62	2.12	2.44	2.55	1.86	2.86
	QN	6.37	7.26	7.17	5.75	6.05	5.41	5.17	5.99	6.90	6.45	6.71	9.56
	OBS	129	130	108	166	136	161	207	102	120	122	107	91
37 N	QS	1.42	2.11	2.57	3.17	3.58	3.22	3.39	3.24	2.58	2.16	1.50	1.22
123 W	QB	1.68	1.67	1.48	1.45	1.48	1.24	1.33	1.38	1.31	1.50	1.52	1.75
	QE	3.22	4.04	3.41	2.85	2.99	2.03	1.97	2.03	2.20	3.26	3.39	4.17
	QC	1.61	1.64	1.54	1.55	1.59	1.19	1.21	1.25	1.21	1.42	1.36	1.79
	QN	4.69	5.44	4.83	4.54	4.70	3.55	3.74	3.77	3.54	4.44	4.67	5.86
	OBS	320	308	378	378	370	540	502	469	500	376	358	294
37 N	QS	1.29	1.73	2.38	3.02	3.75	4.07	4.27	3.77	3.01	2.41	1.39	1.15
124 W	QB	1.50	1.35	1.34	1.41	1.51	1.56	1.66	1.59	1.52	1.58	1.36	1.50
	QE	3.38	2.90	2.85	3.00	3.21	3.29	2.79	2.69	3.03	3.58	3.11	3.62
	QC	1.70	1.30	1.43	1.64	1.68	1.67	1.63	1.66	1.49	1.71	1.37	1.63
	QN	4.98	4.06	4.18	4.51	5.18	5.16	4.73	4.74	4.54	5.21	4.42	5.02
	OBS	346	381	418	361	330	350	334	329	335	335	401	332
37 N	QS	1.04	1.53	2.08	2.52	2.80	3.49	3.40	3.20	2.65	1.94	1.12	.93
125 W	QB	1.16	1.20	1.14	1.15	1.11	1.31	1.29	1.29	1.29	1.23	1.13	1.19
	QE	2.41	2.84	2.50	2.77	2.41	2.65	2.42	2.26	2.57	2.97	2.73	2.83
	QC	1.24	1.35	1.32	1.44	1.29	1.49	1.36	1.29	1.27	1.20	1.20	1.45
	QN	3.52	4.01	3.69	4.11	3.71	4.49	4.02	3.92	3.84	4.06	3.87	4.15
	OBS	517	466	552	537	527	449	462	452	452	494	585	487
37 N	QS	1.17	1.64	2.25	2.60	3.10	3.29	3.58	3.39	2.84	1.96	1.20	.99
126 W	QB	1.26	1.27	1.21	1.16	1.21	1.20	1.34	1.32	1.38	1.28	1.15	1.23
	QE	2.78	3.13	2.72	3.03	2.63	2.39	2.52	2.61	2.66	3.26	3.43	3.02
	QC	1.44	1.62	1.41	1.59	1.31	1.35	1.35	1.44	1.22	1.28	1.39	1.40
	QN	4.15	4.50	4.03	4.64	4.17	3.96	4.10	4.55	3.86	4.40	4.79	4.29
	OBS	408	367	463	481	442	451	396	379	384	430	477	424
37 N	QS	1.32	1.97	2.67	3.12	3.14	3.89	3.81	3.92	3.16	2.13	1.41	1.13
127 W	QB	1.45	1.51	1.45	1.40	1.20	1.43	1.35	1.53	1.52	1.32	1.30	1.40
	QE	3.73	4.05	3.43	3.38	2.76	3.20	2.97	3.04	3.35	3.83	3.77	3.82
	QC	1.84	1.95	1.79	1.65	1.28	1.60	1.57	1.49	1.61	1.61	1.57	1.79
	QN	5.45	5.77	5.09	5.06	4.26	5.05	4.65	5.11	4.93	5.15	5.24	5.41
	OBS	266	252	279	319	359	279	271	260	277	331	336	270
37 N	QS	1.57	2.25	2.95	3.16	3.84	4.07	4.48	4.54	3.33	2.30	1.55	1.20
128 W	QB	1.80	1.67	1.45	1.38	1.43	1.45	1.57	1.68	1.56	1.48	1.48	1.54
	QE	4.47	4.74	4.89	3.79	3.08	3.30	3.85	3.77	3.78	3.91	5.10	5.02
	QC	2.31	2.32	2.33	2.01	1.65	1.67	1.63	1.68	1.69	1.50	2.01	2.14
	QN	5.39	6.71	7.06	5.78	5.00	5.24	6.00	6.13	5.42	5.27	7.01	7.11
	OBS	190	180	216	242	262	237	191	189	247	271	227	221
37 N	QS	1.65	2.29	3.11	3.47	3.91	4.21	4.04	4.37	3.34	2.31	1.49	1.24
129 W	QB	1.73	1.82	1.62	1.58	1.45	1.47	1.34	1.58	1.52	1.39	1.36	1.56
	QE	5.01	5.33	5.19	3.84	3.57	3.90	3.65	4.02	4.74	4.05	5.04	5.30
	QC	2.10	2.68	2.46	2.22	1.87	1.72	1.63	1.78	1.75	1.82	1.94	2.53
	QN	6.97	7.58	7.68	5.97	5.88	5.96	5.75	6.33	6.44	5.73	6.73	7.63
	OBS	160	154	186	227	222	222	183	186	231	272	236	183
37 N	QS	1.70	2.38	3.29	3.45	4.05	4.10	4.31	4.35	3.35	2.40	1.52	1.20
130 W	QB	1.80	1.72	1.69	1.46	1.50	1.45	1.46	1.57	1.55	1.44	1.47	1.51
	QE	5.44	6.60	4.91	4.37	3.22	3.57	3.22	4.27	4.21	3.83	5.14	6.49
	QC	2.55	3.15	2.35	1.97	1.75	1.67	1.51	1.69	1.52	1.36	2.00	2.64
	QN	7.66	9.56	7.05	6.32	5.38	5.41	5.51	6.67	5.64	4.86	7.03	8.93
	OBS	148	149	154	221	205	213	187	181	231	247	204	180
37 N	QS	1.64	2.61	3.57	3.63	3.99	4.69	4.13	4.43	3.22	2.51	1.62	1.32
131 W	QB	1.84	1.88	1.88	1.57	1.47	1.61	1.35	1.57	1.47	1.57	1.50	1.67
	QE	5.11	5.67	5.45	4.43	3.70	3.99	3.83	3.69	4.36	4.78	6.07	6.05
	QC	3.08	3.04	3.15	2.44	1.72	1.75	1.81	1.47	1.37	1.79	1.98	2.52
	QN	8.95	8.29	8.01	6.95	5.85	6.63	6.25	5.88	5.81	6.49	7.93	8.28
	OBS	140	131	138	198	174	175	177	176	198	221	190	162

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
38 N	QS	1.17	1.56	2.16	2.43	3.15	3.28	3.16	3.04	2.49	1.99	1.33	.98
123 W	QB	1.40	1.24	1.22	1.19	1.32	1.26	1.23	1.34	1.31	1.41	1.38	1.40
	QE	2.34	1.99	2.16	2.32	2.12	1.94	1.65	1.99	1.71	2.14	1.89	2.44
	QC	1.19	1.10	1.09	1.27	1.36	1.29	1.12	1.28	1.07	1.25	.87	1.29
	QN	3.42	2.90	3.22	3.50	3.61	3.44	3.33	3.55	2.94	3.11	2.66	3.61
	OBS	484	513	575	594	479	540	583	537	505	451	443	446
38 N	QS	1.79	2.42	3.44	3.42	4.02	3.95	4.30	3.65	3.35	2.97	1.82	1.33
124 W	QB	2.17	1.93	1.92	1.60	1.64	1.52	1.69	1.56	1.67	1.90	1.85	1.78
	QE	3.88	4.31	3.87	3.30	3.26	2.72	2.93	2.86	2.77	3.67	4.66	4.46
	QC	1.95	2.43	1.68	1.57	1.82	1.71	2.07	1.78	1.54	1.62	2.01	2.16
	QN	5.57	6.37	5.41	4.53	5.18	4.68	5.43	5.01	4.43	5.09	6.41	6.19
	OBS	181	206	211	296	291	370	318	344	314	238	233	224
38 N	QS	1.98	2.73	3.91	4.01	4.48	4.95	5.22	4.29	3.71	3.22	2.14	1.70
125 W	QB	2.42	2.34	2.24	1.85	1.72	1.87	2.02	1.76	1.88	2.17	2.11	2.32
	QE	5.75	5.58	5.46	3.99	4.22	3.97	4.06	3.26	3.46	5.24	4.02	5.23
	QC	2.90	2.85	2.36	1.92	2.00	2.30	2.66	1.90	1.80	2.38	1.84	2.33
	QN	8.45	8.10	7.24	5.64	6.37	6.82	7.22	5.65	5.61	7.29	5.79	7.32
	OBS	124	132	153	205	187	221	216	250	212	165	169	136
38 N	QS	2.46	2.87	4.27	4.63	4.75	5.64	5.23	4.59	3.88	3.38	2.25	1.57
126 W	QB	2.71	2.30	2.35	2.23	1.90	2.04	1.92	1.83	1.94	2.14	2.13	2.09
	QE	6.96	4.81	5.26	5.96	4.58	4.58	4.08	4.32	4.70	5.13	5.31	6.46
	QC	4.36	2.64	2.56	3.15	2.04	2.50	2.22	2.42	2.16	2.21	2.49	2.76
	QN	11.16	7.09	7.83	8.86	6.85	7.17	6.95	6.89	6.79	7.06	7.73	9.03
	OBS	95	137	120	139	151	161	187	205	202	163	135	136
38 N	QS	2.33	3.33	3.76	4.61	4.45	4.94	4.26	3.97	3.89	3.05	2.21	1.65
127 W	QB	2.63	2.66	2.03	2.00	1.74	1.78	1.59	1.53	1.84	1.97	2.08	2.30
	QE	8.32	5.57	5.10	5.14	3.91	4.81	4.03	4.46	4.50	6.00	5.38	6.08
	QC	4.19	2.50	3.06	2.69	1.72	2.17	2.18	2.02	2.00	2.30	2.20	2.71
	QN	12.54	7.85	7.80	7.62	6.08	6.97	5.48	6.55	6.51	8.19	7.26	8.62
	OBS	90	88	129	137	179	188	222	213	187	150	134	114
38 N	QS	2.23	3.27	4.03	4.64	3.81	4.24	3.78	3.80	3.31	3.08	2.08	1.50
128 W	QB	2.39	2.63	2.21	2.07	1.47	1.50	1.36	1.41	1.57	1.89	1.88	1.98
	QE	9.66	5.93	5.31	4.51	3.25	3.61	3.46	3.28	3.66	5.88	6.28	6.69
	QC	4.68	3.28	2.84	2.37	1.69	1.98	1.79	1.47	1.66	2.34	2.40	2.96
	QN	14.26	8.72	8.03	6.64	5.03	5.74	5.58	5.20	5.16	7.92	8.53	9.47
	OBS	98	99	124	141	207	207	244	253	254	165	141	120
38 N	QS	1.77	2.71	3.62	4.37	4.72	4.76	4.19	4.10	3.59	3.09	2.05	1.44
129 W	QB	2.19	2.16	2.16	1.97	1.80	1.67	1.44	1.59	1.67	1.92	1.99	1.93
	QE	7.64	5.29	5.88	4.86	3.43	3.99	3.47	4.55	4.54	5.39	6.86	6.60
	QC	4.04	2.95	3.03	2.49	1.81	2.08	1.89	1.82	1.81	1.94	2.85	3.07
	QN	11.55	8.80	8.68	7.45	5.81	6.63	6.05	6.64	6.27	7.08	9.48	9.29
	OBS	95	113	121	122	174	172	219	203	193	146	131	117
38 N	QS	2.18	3.10	4.19	4.60	4.69	5.01	4.27	4.02	3.60	3.26	1.88	1.50
130 W	QB	2.57	2.32	2.18	1.99	1.78	1.74	1.48	1.56	1.66	2.04	1.99	2.00
	QE	9.21	6.41	6.72	5.76	3.90	3.99	4.33	4.07	4.31	6.48	8.39	7.21
	QC	5.04	3.45	3.51	2.37	2.38	2.09	1.67	1.69	1.47	2.03	2.95	2.61
	QN	14.15	9.86	10.12	8.30	6.46	6.76	6.59	5.94	5.53	8.35	10.92	9.73
	OBS	84	105	108	100	152	156	170	188	185	132	110	117
38 N	QS	2.01	2.92	4.09	4.79	4.38	5.35	4.13	4.25	4.04	3.11	2.20	1.46
131 W	QB	2.25	2.42	2.38	2.14	1.65	1.91	1.41	1.47	1.34	1.97	2.12	1.98
	QE	6.73	7.47	8.48	6.72	3.87	4.55	3.40	3.50	5.51	6.64	7.07	7.64
	QC	3.46	4.10	3.68	3.27	1.84	2.11	1.88	1.46	2.04	2.27	2.65	3.25
	QN	9.90	11.30	11.71	9.94	5.67	7.49	5.67	5.68	7.15	8.78	9.35	10.74
	OBS	93	85	84	99	150	143	158	190	144	121	104	96
38 N	QS	2.25	3.11	3.62	4.89	4.82	5.46	4.46	4.33	3.87	3.13	1.99	1.48
132 W	QB	2.34	2.22	2.06	2.19	1.87	1.91	1.49	1.56	1.73	2.01	1.80	1.99
	QE	9.31	7.39	5.18	7.73	4.04	4.10	3.48	4.33	4.83	6.98	6.87	8.95
	QC	5.14	3.23	2.73	3.85	1.91	1.81	1.31	1.51	1.72	2.10	2.92	3.75
	QN	14.33	10.30	7.48	11.80	6.47	6.53	5.68	6.63	6.73	8.66	9.45	12.37
	OBS	73	78	112	99	141	126	153	166	168	136	124	101

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
39 N	QS	1.78	2.18	3.50	3.75	4.69	4.47	4.80	4.42	3.96	3.03	1.78	1.43
124 W	QB	2.26	1.86	2.00	1.82	2.00	1.76	1.91	1.89	2.04	2.07	1.99	2.13
	QE	4.37	3.67	3.63	3.11	3.36	2.93	2.76	3.37	2.71	4.34	3.68	4.15
	QC	2.36	1.70	1.86	1.83	2.20	2.03	2.15	2.31	1.75	2.20	1.39	2.06
	QN	6.29	4.92	5.13	4.78	5.51	4.99	5.68	6.30	4.57	6.30	4.85	6.12
	OBS	159	218	211	257	217	282	260	232	213	197	195	176
39 N	QS	2.24	3.75	4.82	5.25	5.62	5.87	5.49	5.10	4.74	3.71	2.73	2.04
125 W	QB	2.77	2.97	2.73	2.54	2.21	2.22	2.07	2.15	2.35	2.38	3.04	3.00
	QE	4.80	5.35	5.53	5.15	4.68	5.16	4.32	4.17	4.72	6.23	6.36	7.08
	QC	2.84	2.74	3.13	3.11	2.33	3.18	2.73	2.77	2.64	2.75	2.84	3.42
	QN	7.55	7.88	8.41	7.90	7.19	8.35	7.37	7.00	7.55	8.52	9.40	10.14
	OBS	99	93	97	125	136	166	177	175	146	129	86	81
39 N	QS	2.26	3.09	4.56	4.80	5.25	5.10	4.89	4.36	4.10	3.61	2.34	2.18
126 W	QB	2.94	2.92	2.52	2.30	2.10	1.88	1.84	1.72	1.99	2.47	2.46	3.18
	QE	8.10	5.45	6.21	4.87	4.52	3.96	3.64	3.73	4.37	5.54	6.68	9.02
	QC	3.41	3.12	3.65	2.30	2.14	2.01	2.43	2.18	1.92	1.95	2.80	3.97
	QN	11.30	8.45	9.88	7.07	7.09	6.17	6.73	6.09	6.02	7.24	9.14	12.75
	OBS	82	81	97	129	156	184	204	209	163	111	114	76
39 N	QS	2.23	3.40	4.77	4.86	5.79	6.24	5.88	5.15	4.94	3.24	2.60	1.87
127 W	QB	2.94	2.83	2.78	2.32	2.39	2.27	2.12	2.00	2.27	2.38	2.63	2.76
	QE	7.49	5.60	5.91	6.05	7.13	5.47	4.68	5.42	6.21	6.54	7.97	7.78
	QC	4.02	2.90	3.75	3.23	3.46	2.75	3.20	2.68	2.76	2.71	3.24	3.87
	QN	11.44	8.51	9.36	9.04	9.92	8.20	7.90	8.75	8.67	8.93	10.32	11.54
	OBS	60	77	85	119	88	108	122	160	113	101	87	80
39 N	QS	2.08	3.47	4.53	5.16	5.71	6.71	6.02	5.03	4.14	4.05	2.53	2.29
128 W	QB	2.55	2.73	2.63	2.26	2.17	2.41	2.16	2.02	2.09	2.66	2.52	3.22
	QE	7.98	5.78	6.39	7.42	6.34	5.42	4.47	5.34	4.97	7.37	9.00	9.02
	QC	4.66	3.58	3.31	3.67	3.13	2.47	2.25	2.53	2.10	2.92	3.51	4.08
	QN	12.09	8.63	9.26	10.66	9.78	8.70	7.53	7.90	6.25	9.95	12.20	12.89
	OBS	68	76	77	95	95	104	140	131	141	81	85	63
39 N	QS	2.26	3.34	3.87	4.60	4.93	5.72	4.78	4.62	4.17	3.56	2.35	1.57
129 W	QB	2.53	2.59	2.26	2.03	1.87	2.01	1.62	1.67	1.95	2.45	2.40	2.15
	QE	6.39	5.81	5.46	5.59	4.69	4.52	4.65	5.06	5.50	6.62	8.58	7.82
	QC	3.30	3.33	2.71	3.00	2.28	2.38	1.97	1.97	1.88	2.18	3.53	3.46
	QN	9.33	8.66	7.69	8.45	7.40	7.68	7.42	7.74	7.38	8.46	11.78	10.94
	OBS	66	89	112	115	116	127	156	134	137	94	97	95
39 N	QS	1.52	2.20	3.82	3.64	3.66	4.84	4.16	4.19	4.35	3.33	2.35	1.24
130 W	QB	1.82	1.85	2.15	1.63	1.44	1.71	1.45	1.50	1.88	2.11	2.29	1.80
	QE	4.65	4.27	4.99	3.62	3.13	3.59	3.60	4.55	5.41	7.34	7.69	5.04
	QC	2.54	2.32	2.32	2.07	1.47	1.74	1.65	1.64	1.69	2.28	3.84	2.48
	QN	7.16	5.89	7.41	5.69	5.03	6.00	5.60	5.71	7.56	9.71	11.15	7.34
	OBS	154	169	119	172	224	159	186	184	142	118	98	162
39 N	QS	2.22	3.19	3.60	4.90	4.58	5.34	3.50	4.44	3.82	3.06	1.93	1.53
131 W	QB	2.60	2.85	2.18	2.18	1.68	1.87	1.20	1.58	1.72	2.05	1.93	2.18
	QE	8.23	5.70	6.69	4.59	3.29	4.66	2.70	3.44	4.71	7.26	7.76	7.02
	QC	4.60	2.97	3.31	2.53	1.89	2.24	1.34	1.21	1.72	2.77	3.47	3.17
	QN	12.17	9.51	9.80	7.51	5.84	7.18	4.67	5.42	6.44	3.73	10.80	10.10
	OBS	60	75	100	108	160	127	226	201	159	111	109	95
39 N	QS	1.85	3.62	4.26	5.34	5.79	5.45	4.80	4.50	3.61	3.67	2.14	1.58
132 W	QB	2.28	2.90	2.37	2.54	2.23	1.97	1.67	1.65	1.67	2.46	1.98	2.22
	QE	9.39	9.38	7.01	6.07	5.30	4.24	3.74	4.77	5.79	7.23	9.79	10.08
	QC	5.28	4.72	3.27	2.95	2.81	1.80	1.68	1.66	1.78	2.37	4.05	4.49
	QN	14.33	13.89	10.19	9.29	8.34	6.76	6.24	7.25	7.46	8.99	13.58	14.66
	OBS	79	54	96	99	104	129	165	142	147	89	101	89
39 N	QS	2.12	3.02	3.95	5.54	4.93	4.80	3.91	4.72	3.96	2.51	1.61	1.53
133 W	QB	2.39	2.48	2.20	2.51	1.87	1.72	1.36	1.76	1.87	1.56	1.69	2.17
	QE	11.15	7.59	7.05	6.56	4.75	3.73	3.48	4.62	5.03	4.81	6.97	8.00
	QC	4.78	4.08	3.81	3.13	2.33	1.70	1.54	2.07	1.58	1.86	2.67	3.67
	QN	16.08	11.51	10.59	9.76	7.05	6.02	5.62	7.28	6.73	6.60	9.45	11.60
	OBS	74	64	97	87	111	140	157	123	147	190	134	92

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
40 N	QS	1.13	1.58	2.29	2.53	3.36	4.05	4.65	4.78	3.10	2.83	1.60	1.21
124 W	QB	1.57	1.30	1.28	1.25	1.32	1.52	1.82	1.95	1.68	2.00	1.74	1.95
	QE	2.78	1.84	1.79	1.57	2.05	2.07	2.55	2.50	2.67	2.93	2.32	3.09
	QC	1.47	1.03	1.07	.95	1.50	1.67	1.89	1.83	2.02	1.97	1.51	1.67
	QN	4.14	2.83	2.50	2.39	4.26	4.41	5.26	5.17	5.10	4.96	3.67	4.47
	OBS	340	404	506	505	431	324	264	224	228	209	227	211
40 N	QS	2.12	3.15	3.91	4.99	7.04	5.88	6.43	5.51	5.12	3.79	2.14	1.64
125 W	QB	2.32	2.65	2.51	2.39	2.89	2.21	2.49	2.39	2.69	2.80	2.46	2.70
	QE	7.35	5.39	5.10	4.78	5.22	3.60	4.41	4.04	5.30	5.83	5.22	7.56
	QC	3.73	3.16	3.17	2.74	3.14	2.39	3.00	2.94	3.17	2.97	2.86	4.24
	QN	10.68	8.06	7.59	7.37	8.36	6.33	8.56	7.32	8.26	8.36	7.78	11.79
	OBS	101	102	115	148	99	156	141	151	123	109	122	93
40 N	QS	2.40	5.16	6.03	6.86	7.54	8.30	8.01	7.05	6.45	4.79	3.20	2.31
126 W	QB	3.31	4.45	3.51	3.20	3.10	3.18	2.96	2.92	3.20	3.57	3.55	3.49
	QE	8.28	6.38	11.01	6.17	6.81	5.63	5.22	5.13	6.41	8.33	9.38	9.82
	QC	3.66	3.70	6.05	3.81	3.46	3.62	3.39	2.88	2.75	3.69	4.67	5.29
	QN	11.65	9.74	16.41	9.74	9.75	8.25	9.01	8.33	9.34	11.88	13.57	15.16
	OBS	50	46	52	67	79	77	83	90	70	55	60	55
40 N	QS	2.22	3.85	4.95	5.48	6.21	5.72	5.37	4.81	5.61	3.71	3.64	2.39
127 W	QB	3.33	3.52	3.20	2.38	2.53	2.03	1.90	2.01	2.72	2.46	3.98	3.81
	QE	7.26	7.18	6.19	4.59	5.37	4.15	5.63	5.03	6.44	6.94	9.23	8.77
	QC	4.14	4.26	3.16	2.98	2.60	2.00	2.49	2.08	2.87	2.68	3.44	4.19
	QN	11.50	10.92	8.86	7.72	8.01	6.49	8.26	7.07	9.13	9.19	12.66	13.09
	OBS	62	57	66	99	93	122	122	165	86	104	54	47
40 N	QS	1.22	3.22	4.74	4.69	5.63	5.02	4.60	4.63	4.41	3.87	3.07	1.59
128 W	QB	1.65	2.87	2.60	2.24	2.27	1.80	1.63	1.78	2.17	2.55	3.29	2.44
	QE	5.32	6.30	6.30	4.74	4.13	3.81	3.64	4.57	5.70	6.27	9.10	7.22
	QC	2.39	3.64	3.19	2.33	2.02	2.12	1.73	1.84	2.17	2.71	3.58	3.72
	QN	7.60	9.47	9.42	7.00	6.84	5.98	6.14	6.61	7.78	8.78	11.90	10.70
	OBS	147	70	79	119	112	156	182	156	121	102	59	95
40 N	QS	1.59	2.70	3.05	3.67	4.50	4.87	4.60	4.74	4.38	2.66	2.24	1.91
129 W	QB	2.18	2.24	1.72	1.75	1.71	1.75	1.52	1.78	2.01	2.06	2.37	2.82
	QE	7.36	5.35	4.28	4.21	3.83	4.21	4.00	4.52	5.28	6.27	8.28	7.94
	QC	3.99	2.67	2.67	2.31	1.93	2.14	1.88	2.04	1.90	2.22	3.26	3.46
	QN	11.07	7.87	6.80	6.03	5.96	6.72	6.56	7.07	7.24	8.11	10.95	11.04
	OBS	85	93	149	165	140	124	150	144	131	130	105	74
40 N	QS	2.07	2.41	2.17	2.81	3.03	3.05	3.22	3.47	3.02	2.07	1.68	1.65
130 W	QB	2.14	1.90	1.32	1.38	1.21	1.04	1.11	1.20	1.42	1.51	1.66	2.45
	QE	5.65	4.40	3.13	4.00	2.77	3.41	3.17	4.37	4.86	3.88	5.72	7.72
	QC	3.21	2.30	1.47	2.06	1.16	1.46	1.50	1.69	1.67	1.33	2.25	3.55
	QN	8.77	6.56	4.37	5.76	4.08	4.97	4.70	6.17	6.36	5.17	7.73	11.07
	OBS	113	156	274	262	269	258	266	208	194	225	194	95
40 N	QS	2.10	3.54	4.16	5.87	5.10	6.33	5.75	5.05	4.12	3.49	2.74	1.61
131 W	QB	2.70	2.71	2.34	2.40	1.92	2.22	1.96	1.84	1.85	2.53	2.79	2.54
	QE	8.70	7.23	6.32	6.28	4.96	5.22	4.56	4.89	5.70	7.17	10.15	9.38
	QC	4.98	3.49	3.43	3.37	3.02	2.28	2.04	1.91	2.08	3.00	4.45	4.48
	QN	13.84	10.99	9.50	10.50	8.03	8.46	7.58	7.47	7.60	9.84	14.16	13.54
	OBS	61	73	85	94	94	96	107	126	105	80	79	78
40 N	QS	1.97	2.36	3.80	5.07	5.48	4.99	4.58	4.14	4.26	3.08	2.18	1.57
132 W	QB	2.46	2.18	2.25	2.37	2.04	1.80	1.58	1.43	1.96	2.00	2.23	2.50
	QE	8.11	5.61	5.74	6.99	3.92	4.15	3.91	4.38	5.05	6.73	8.50	9.88
	QC	4.70	2.38	3.23	3.60	2.15	1.58	1.40	1.67	1.68	2.43	4.15	4.84
	QN	13.00	7.71	8.87	10.50	6.38	6.49	5.82	6.25	7.11	8.99	12.66	14.52
	OBS	77	80	92	87	114	124	145	152	124	119	98	82
40 N	QS	1.80	3.08	3.25	3.49	5.02	4.50	3.62	3.56	3.09	2.33	1.66	1.23
133 W	QB	2.33	2.63	1.85	1.57	1.99	1.52	1.22	1.26	1.43	1.53	1.75	1.92
	QE	8.34	5.93	5.49	4.41	3.61	3.04	2.93	3.69	4.23	3.88	7.13	7.77
	QC	4.79	3.09	2.94	2.14	2.19	1.43	1.23	1.27	1.56	1.36	2.92	3.24
	QN	12.78	8.37	8.00	6.84	6.44	5.74	4.72	5.16	5.71	5.23	10.15	10.94
	OBS	88	83	117	180	129	193	186	199	219	204	127	112

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
41 N	QS	3.96	6.90	9.45	10.36	14.16	15.08	15.08	14.68	11.04	7.45	5.49	5.29
124 W	QB	4.68	6.38	5.66	5.25	5.70	5.60	5.92	5.97	5.95	5.44	8.05	8.37
	QE	9.75	10.65	7.05	7.92	5.53	6.77	7.41	4.84	6.65	17.68	11.73	14.34
	QC	4.58	7.59	3.62	5.45	5.18	5.48	6.12	3.24	5.41	10.84	5.84	9.36
	QN	14.05	19.25	11.23	11.20	13.49	12.00	17.16	10.93	11.99	27.03	19.53	20.20
	OBS	19	21	25	26	24	25	26	24	22	23	17	10
41 N	QS	1.90	2.63	3.65	4.51	5.96	5.95	5.90	5.65	5.14	3.53	1.92	1.57
125 W	QB	2.71	2.26	2.26	2.20	2.39	2.24	2.24	2.39	2.63	2.54	2.36	2.69
	QE	6.37	4.62	3.76	4.35	3.60	3.82	3.46	3.09	4.41	4.65	4.12	6.66
	QC	3.24	2.64	2.03	2.70	2.45	2.34	2.36	2.33	2.48	2.47	2.04	3.21
	QN	9.36	6.85	5.30	7.27	6.34	6.40	7.26	6.26	6.54	7.24	5.85	9.43
	OBS	107	149	156	151	140	160	162	153	130	137	145	98
41 N	QS	4.05	4.65	5.70	6.61	7.49	8.82	8.31	8.06	7.44	4.65	3.41	2.11
126 W	QB	5.16	3.99	3.19	3.29	2.93	3.36	3.19	3.28	3.66	3.36	3.94	3.77
	QE	9.93	7.39	6.39	8.53	5.73	6.74	6.76	4.80	8.00	6.92	7.68	9.00
	QC	6.54	5.66	3.82	4.86	1.89	4.83	3.67	3.71	4.35	3.78	3.70	4.27
	QN	15.96	12.10	9.36	13.29	7.84	11.91	10.84	8.58	12.15	10.10	11.39	13.72
	OBS	34	41	50	66	78	71	70	68	66	70	53	55
41 N	QS	2.52	3.82	7.10	6.39	6.93	9.68	9.29	8.81	8.90	5.22	3.71	2.39
127 W	QB	3.30	3.17	3.93	3.18	2.98	3.40	3.36	3.54	4.62	4.17	4.52	4.04
	QE	8.26	7.67	11.09	6.25	5.45	6.57	7.80	7.39	11.89	9.51	11.60	13.03
	QC	5.35	4.08	4.80	4.29	2.93	4.70	5.32	4.03	6.29	3.91	5.39	7.99
	QN	13.33	11.63	14.79	10.01	8.51	13.93	14.03	12.20	14.98	12.55	16.54	20.91
	OBS	46	45	42	57	78	45	46	56	33	43	37	38
41 N	QS	2.82	4.70	7.46	6.87	9.39	10.11	7.10	7.07	7.32	5.37	2.53	2.70
128 W	QB	4.05	4.30	4.48	3.22	3.56	3.53	2.54	2.92	3.77	3.93	3.34	4.13
	QE	11.49	7.84	7.56	5.44	8.41	7.94	6.49	6.95	8.36	10.55	13.59	10.66
	QC	5.56	4.72	5.48	3.49	3.53	4.61	3.05	3.41	2.91	3.74	6.14	5.33
	QN	17.04	12.14	12.45	8.92	12.68	14.29	9.64	11.39	9.68	13.56	18.64	15.53
	OBS	40	30	34	50	42	51	65	59	44	46	40	33
41 N	QS	1.64	3.73	5.42	5.80	7.43	6.83	6.01	6.19	5.00	4.34	3.22	1.64
129 W	QB	2.43	3.01	2.85	2.73	2.92	2.38	2.13	2.28	2.56	2.64	3.57	2.87
	QE	8.47	9.34	6.29	4.55	4.03	4.45	5.87	6.72	6.38	8.73	10.59	8.97
	QC	4.51	5.53	3.78	2.90	2.34	2.70	2.97	2.47	2.95	3.45	4.83	4.72
	QN	13.00	15.09	9.88	7.24	7.58	7.63	9.73	8.98	8.76	11.71	15.45	13.63
	OBS	57	47	57	76	75	77	90	77	74	71	53	57
41 N	QS	1.87	3.11	3.84	4.22	5.25	4.93	5.45	4.16	4.11	3.26	2.58	1.58
130 W	QB	2.41	2.82	2.21	1.98	2.16	1.72	1.86	1.54	2.08	1.98	2.59	2.78
	QE	8.89	7.06	5.41	4.47	3.73	3.64	4.10	4.30	5.78	5.37	8.88	6.36
	QC	4.96	3.85	2.65	2.65	1.57	2.06	1.85	1.63	1.73	1.83	2.59	3.08
	QN	13.59	10.47	7.55	7.27	5.55	6.48	7.40	6.22	7.36	6.99	11.12	9.51
	OBS	65	68	93	119	132	139	141	174	115	124	79	70
41 N	QS	1.59	2.38	2.97	3.88	4.54	5.11	3.87	3.78	3.53	2.70	2.02	1.39
131 W	QB	1.92	2.07	1.68	1.77	1.78	1.89	1.41	1.41	1.58	1.91	2.21	2.34
	QE	7.24	5.16	5.66	4.34	3.51	3.35	3.00	3.63	5.32	5.32	7.45	9.09
	QC	4.33	3.05	3.30	2.55	1.80	1.48	1.55	1.53	1.48	2.32	3.02	4.75
	QN	11.74	7.94	8.61	7.28	5.29	5.13	4.83	5.31	6.67	7.27	10.14	13.76
	OBS	93	106	136	167	150	138	203	212	147	134	109	84
41 N	QS	1.38	3.48	4.86	5.05	5.43	5.86	4.92	5.71	4.85	3.21	2.03	1.39
132 W	QB	2.38	2.55	2.60	2.39	2.17	2.09	1.63	2.13	2.25	2.15	2.63	2.41
	QE	3.59	7.11	8.12	5.71	5.57	3.98	4.28	6.42	6.58	6.28	9.53	10.62
	QC	5.34	4.32	4.58	3.11	2.39	2.42	1.86	2.23	2.26	2.40	3.74	5.71
	QN	14.87	10.85	12.66	8.54	8.86	7.42	6.78	9.11	8.93	8.26	12.85	15.91
	OBS	62	58	65	91	89	95	93	86	84	101	77	74
41 N	QS	2.13	3.36	4.21	5.75	6.77	5.61	6.04	6.20	5.60	3.26	2.09	1.72
133 W	QB	2.77	2.75	2.62	2.75	2.66	1.99	2.15	2.33	2.71	2.27	2.38	2.92
	QE	12.58	5.76	8.48	5.91	5.71	4.80	5.26	5.12	6.18	8.18	11.15	9.90
	QC	6.32	4.09	4.85	3.10	3.12	2.25	2.44	1.92	2.56	3.35	5.65	5.73
	QN	13.85	9.21	12.84	8.66	9.10	7.62	8.78	8.26	8.76	11.03	16.30	15.51
	OBS	63	61	66	68	64	93	72	79	80	82	62	59

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
42 N	QS	4.40	6.40	13.64	16.44	20.97	15.21	14.65	10.94	11.21	10.23	6.45	5.73
124 W	QB	6.54	6.59	7.96	7.72	8.83	5.63	5.94	4.62	6.11	7.10	7.21	8.75
	QE	14.69	13.55	5.36	10.88	16.69	3.94	10.85	4.05	6.78	15.14	11.13	10.85
	QC	8.85	6.63	3.78	6.36	6.24	3.38	9.49	3.51	4.57	5.05	8.70	6.19
	QN	23.32	19.87	10.02	19.57	14.58	10.14	22.55	10.04	11.34	19.42	18.67	13.31
	OBS	13	19	10	11	11	25	26	31	22	19	14	8
42 N	QS	1.65	2.21	3.69	4.15	6.26	4.89	6.01	5.81	4.67	3.36	1.80	1.48
125 W	QB	2.43	1.98	2.34	2.08	2.62	1.85	2.37	2.44	2.49	2.48	2.34	2.83
	QE	5.51	3.58	3.51	3.49	4.15	3.30	3.64	3.52	4.59	4.10	4.10	6.96
	QC	3.01	1.70	1.99	2.13	2.89	2.29	2.70	2.71	2.74	2.34	1.98	3.75
	QN	8.25	4.80	5.25	5.18	6.87	5.99	6.81	6.84	7.40	6.53	5.82	10.03
	OBS	112	154	165	179	123	209	158	136	135	140	144	110
42 N	QS	2.94	5.25	6.81	6.50	8.53	11.64	9.90	9.48	10.49	5.83	3.91	2.55
126 W	QB	3.85	4.54	3.94	3.31	3.26	4.18	3.65	3.68	5.41	3.90	4.25	4.44
	QE	8.60	8.89	6.58	6.50	7.43	8.38	8.11	7.50	10.52	7.68	10.49	9.63
	QC	4.74	4.05	3.82	3.55	4.65	4.61	4.77	4.68	5.50	4.31	3.99	6.30
	QN	13.23	12.60	9.28	9.32	13.24	13.13	13.28	13.77	15.44	10.53	14.26	15.78
	OBS	38	41	40	45	48	39	45	46	31	40	38	29
42 N	QS	2.94	4.48	5.34	6.03	7.29	9.12	9.38	8.85	7.57	5.26	2.72	1.73
127 W	QB	4.09	3.96	3.23	2.67	2.74	3.32	3.43	3.35	3.57	3.62	3.23	3.14
	QE	8.71	6.09	6.08	7.48	6.27	4.96	7.12	5.47	9.48	10.48	7.44	8.89
	QC	5.08	3.33	3.04	4.77	2.79	4.06	4.84	2.98	4.99	4.76	3.77	4.56
	QN	13.33	8.83	8.22	11.95	9.40	8.96	13.16	9.90	14.97	14.69	11.02	13.34
	OBS	48	34	68	66	51	51	57	48	51	47	58	60
42 N	QS	2.84	3.98	5.73	6.49	7.76	9.95	7.63	7.47	8.31	5.17	2.79	1.65
128 W	QB	3.80	3.94	3.65	3.58	3.06	3.74	2.58	2.94	4.19	3.91	3.14	3.08
	QE	6.84	7.69	5.24	7.41	4.67	6.29	6.18	10.39	11.32	10.21	10.00	8.54
	QC	4.38	3.75	3.07	4.72	2.48	4.12	2.52	4.98	3.21	3.76	4.36	5.70
	QN	10.72	11.20	7.98	11.13	7.62	11.62	10.59	15.93	13.83	13.05	13.76	13.97
	OBS	52	35	52	49	55	46	56	48	35	50	47	57
42 N	QS	1.44	2.66	3.16	3.63	3.97	6.73	6.95	4.80	7.85	4.84	2.33	1.07
129 W	QB	2.33	2.53	1.71	1.56	1.55	2.44	2.47	1.80	3.74	3.94	2.69	1.81
	QE	8.47	6.26	3.97	3.44	4.36	4.43	4.39	4.12	11.79	10.83	7.53	5.60
	QC	4.86	3.50	2.18	2.26	2.06	2.21	2.98	1.67	4.38	3.70	3.48	2.88
	QN	13.21	9.24	5.84	5.88	6.38	7.52	9.01	6.50	15.95	13.41	10.60	8.42
	OBS	109	92	120	131	137	84	84	151	34	43	81	125
42 N	QS	2.16	2.83	4.72	6.06	6.06	6.17	5.71	6.48	7.26	4.35	2.14	1.38
130 W	QB	2.87	2.39	2.68	2.64	2.41	2.19	2.05	2.48	3.55	2.92	2.66	2.35
	QE	9.67	5.32	6.24	5.35	7.65	4.17	3.91	5.96	9.25	11.56	9.49	9.40
	QC	5.33	3.35	3.32	3.39	3.57	1.52	2.22	3.08	3.41	4.55	3.02	4.78
	QN	14.80	8.56	9.63	8.69	11.20	6.65	6.09	10.27	12.82	15.30	12.38	13.84
	OBS	79	76	79	55	64	90	85	61	37	50	76	68
42 N	QS	1.82	2.73	3.26	4.72	7.03	5.47	4.40	4.60	4.12	3.45	1.86	1.45
131 W	QB	2.43	2.33	2.05	2.08	2.73	1.95	1.50	1.67	1.90	2.42	2.21	2.65
	QE	5.82	6.36	6.66	4.56	4.06	4.09	4.12	3.54	6.64	6.35	7.45	9.49
	QC	4.33	3.80	3.53	2.80	1.85	1.60	1.76	1.14	2.09	2.69	3.48	5.00
	QN	9.99	10.08	9.92	7.89	6.81	6.18	6.12	5.83	8.43	8.77	10.51	14.23
	OBS	97	89	106	123	88	102	151	156	124	99	95	79
42 N	QS	1.91	2.96	5.09	4.81	4.45	4.62	4.08	4.03	4.14	2.99	1.99	1.32
132 W	QB	2.50	2.30	2.76	2.29	1.75	1.60	1.44	1.61	2.22	2.05	2.29	2.33
	QE	8.82	7.48	8.00	5.29	3.57	3.87	4.35	3.96	4.68	6.83	11.51	8.30
	QC	5.32	4.74	4.22	2.93	1.84	1.95	2.09	1.64	1.73	2.92	5.63	4.35
	QN	14.41	11.64	12.46	8.11	5.69	6.31	6.89	5.82	6.22	9.48	16.94	12.36
	OBS	69	66	69	117	134	133	161	150	114	116	68	73
42 N	QS	1.49	3.07	3.63	4.02	4.30	4.03	4.34	3.81	3.53	2.98	1.83	1.22
133 W	QB	2.30	2.92	2.01	1.92	1.70	1.46	1.57	1.42	1.75	1.86	2.04	2.28
	QE	10.62	6.61	6.37	5.46	3.99	3.68	3.32	3.95	5.07	6.67	9.78	10.12
	QC	5.70	3.84	3.22	2.92	2.22	1.79	1.59	1.42	1.06	2.65	5.33	4.77
	QN	16.23	9.63	8.95	8.41	6.32	5.63	5.46	5.79	7.05	9.10	14.74	14.70
	OBS	87	70	112	110	156	145	156	167	147	122	78	81

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
43 N	QS	4.29	7.52	13.97	13.58	15.94	17.13	19.74	12.66	7.02	7.27	3.89	5.50
124 W	QB	6.71	7.58	9.56	6.32	6.90	5.80	6.78	5.61	3.85	5.36	7.18	10.45
	QE	8.83	9.81	6.36	9.69	9.68	7.85	8.96	7.82	4.36	5.38	7.65	18.14
	QC	5.81	7.95	4.35	5.18	5.09	4.39	12.18	7.55	5.70	1.80	6.57	9.16
	QN	14.16	18.91	12.19	15.33	20.07	15.43	29.43	17.97	9.28	7.18	11.53	26.69
	OBS	15	20	10	15	13	15	13	16	40	20	8	7
43 N	QS	1.59	1.92	3.51	4.36	5.66	5.29	6.08	6.01	4.84	3.57	1.74	1.28
125 W	QB	2.33	1.94	2.27	2.05	2.32	1.93	2.30	2.40	2.66	2.70	2.28	2.58
	QE	4.90	3.49	4.17	3.55	4.02	3.53	3.47	3.34	4.36	4.48	4.24	5.43
	QC	3.29	2.74	2.32	2.18	2.54	2.61	2.24	2.08	2.88	2.56	2.21	2.99
	QN	8.00	5.79	6.09	5.80	6.52	6.47	6.57	6.22	7.27	6.75	6.31	8.13
	OBS	116	164	151	153	129	176	147	129	115	123	131	104
43 N	QS	2.93	3.37	7.04	8.50	10.35	8.05	11.28	11.30	9.80	6.54	3.32	2.94
126 W	QB	4.47	3.45	4.03	4.23	3.97	2.97	3.76	4.44	5.41	4.74	3.99	5.61
	QE	7.92	8.15	8.42	7.18	6.38	7.59	10.22	7.88	10.35	9.82	7.90	11.30
	QC	5.69	8.26	4.21	3.45	3.44	4.47	5.03	3.84	5.53	3.82	3.36	5.82
	QN	12.42	15.39	12.73	9.12	11.32	11.33	17.65	12.70	15.72	12.33	10.32	17.06
	OBS	33	32	34	33	38	30	28	32	30	33	39	27
43 N	QS	1.46	4.66	4.83	7.35	9.75	11.38	10.06	7.65	9.44	4.17	2.17	1.68
127 W	QB	2.56	3.45	3.03	3.55	4.11	4.05	3.57	3.33	5.12	3.25	3.73	3.21
	QE	9.12	11.58	7.16	8.12	5.35	6.92	6.36	12.61	9.35	8.48	9.28	10.19
	QC	6.27	6.06	3.73	4.18	2.93	3.59	3.83	5.32	2.87	3.94	4.60	6.35
	QN	14.91	16.60	10.33	12.05	8.98	12.86	11.80	16.42	11.10	11.81	13.66	16.72
	OBS	41	30	53	46	35	31	43	40	29	64	42	45
43 N	QS	2.04	3.33	5.57	6.59	8.35	8.71	9.87	4.38	6.91	4.57	2.28	1.61
128 W	QB	2.73	3.24	3.81	3.03	3.00	2.98	3.26	3.72	3.62	3.21	3.01	2.97
	QE	11.05	8.21	6.40	8.23	5.09	6.61	7.77	6.73	8.72	10.90	10.93	9.88
	QC	6.56	4.72	5.19	4.10	3.68	4.15	4.08	3.17	4.79	3.82	4.33	5.94
	QN	17.33	11.88	11.05	11.45	10.10	12.77	14.48	10.39	13.49	14.38	14.47	15.60
	OBS	41	45	49	44	48	42	43	41	44	52	63	58
43 N	QS	2.12	2.70	3.98	6.48	6.02	7.16	9.04	6.36	5.49	4.35	2.24	1.33
129 W	QB	2.93	2.69	2.46	3.04	2.38	2.57	3.24	2.28	2.77	3.34	3.21	2.67
	QE	8.47	5.81	5.38	5.56	5.51	6.36	6.69	8.54	7.21	10.71	9.37	10.88
	QC	4.88	4.41	3.40	4.25	2.58	4.03	3.36	3.59	3.17	3.47	4.34	5.42
	QN	13.29	9.55	8.61	10.34	8.57	10.92	12.03	11.92	10.77	13.22	13.85	16.60
	OBS	63	64	74	63	78	56	50	65	64	50	62	61
43 N	QS	1.11	2.30	2.60	3.02	3.49	4.62	4.20	3.39	3.55	2.79	2.24	.85
130 W	QB	1.62	1.89	1.61	1.40	1.39	1.71	1.41	1.29	1.76	2.02	2.62	1.64
	QE	3.97	4.77	4.05	3.84	2.68	2.69	3.22	3.10	5.21	6.30	7.65	4.98
	QC	2.62	2.71	2.17	1.96	1.41	1.36	1.40	1.19	1.60	2.45	4.12	2.45
	QN	6.51	7.00	5.97	5.76	3.97	4.73	5.76	4.53	6.51	8.34	11.57	7.15
	OBS	197	102	185	192	189	189	185	195	154	119	82	191
43 N	QS	1.75	2.56	3.85	6.38	4.83	5.22	5.25	5.27	4.30	2.77	1.97	1.32
131 W	QB	2.54	2.43	2.54	2.78	1.88	1.91	1.83	2.12	2.26	2.30	2.28	2.62
	QE	7.37	6.56	6.55	6.61	5.19	4.72	4.48	4.93	8.24	7.75	9.14	9.41
	QC	5.62	3.96	3.69	3.67	2.61	2.38	2.04	2.18	2.53	2.70	4.75	5.05
	QN	12.92	10.47	10.31	10.19	8.18	7.87	6.60	7.67	10.12	9.60	13.82	13.89
	OBS	70	84	79	68	86	101	100	106	86	94	72	66
43 N	QS	1.58	3.13	4.11	6.28	6.93	7.49	6.96	6.83	5.24	3.04	2.48	1.71
132 W	QB	2.63	3.11	2.39	3.04	2.69	2.65	2.27	2.72	3.06	2.70	3.01	3.20
	QE	9.68	6.65	6.46	5.16	6.03	5.53	7.07	5.24	7.47	12.46	10.26	11.84
	QC	6.07	4.37	3.25	3.71	3.59	2.74	1.89	2.34	2.42	4.76	5.73	6.54
	QN	15.76	11.07	9.43	9.38	8.57	9.89	10.51	8.75	9.51	16.61	16.03	18.16
	OBS	60	56	77	62	57	55	60	51	53	57	49	52
43 N	QS	1.90	3.50	4.52	6.13	7.18	5.01	5.79	6.35	6.55	3.42	2.07	1.58
133 W	QB	2.86	3.16	2.54	2.76	2.58	1.73	2.11	2.38	3.29	2.56	2.80	2.94
	QE	10.42	9.55	6.76	7.30	6.22	6.46	4.63	5.17	8.89	9.46	12.01	8.19
	QC	5.67	5.04	3.47	3.79	3.08	2.45	2.95	2.46	2.65	4.21	5.51	4.39
	QN	16.16	13.69	9.87	11.07	9.50	8.54	8.29	10.10	11.72	13.21	17.34	12.49
	OBS	54	51	59	59	58	54	63	58	49	70	69	63

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
44 N	QS	3.19	5.03	8.57	9.17	10.80	10.12	12.36	15.65	10.87	6.17	3.14	2.49
124 W	QB	5.61	5.45	5.01	4.87	4.27	3.57	4.76	5.92	6.06	5.06	4.63	4.77
	QE	9.17	9.42	7.48	4.97	4.42	5.78	4.15	5.38	5.67	3.05	6.49	8.28
	QC	6.39	6.33	6.01	3.80	2.98	2.29	2.65	2.50	4.83	2.04	3.17	6.47
	QN	16.04	16.09	13.99	8.07	9.72	9.46	10.71	14.34	10.29	5.82	9.21	14.44
	OBS	22	27	29	35	40	50	39	15	22	29	37	21
44 N	QS	1.44	2.25	3.65	4.12	5.52	4.68	5.51	5.15	4.20	3.06	1.93	1.25
125 W	QB	2.31	2.22	2.37	2.04	2.33	1.67	2.12	2.18	2.19	2.50	2.53	2.80
	QE	5.10	4.02	3.73	3.61	3.92	3.04	3.35	3.95	4.53	4.30	3.70	5.92
	QC	3.79	2.63	1.94	1.94	2.16	2.01	2.16	2.19	2.03	1.84	2.13	3.76
	QN	8.94	6.37	5.51	5.50	6.21	5.70	6.23	6.60	6.75	6.17	5.83	9.75
	OBS	115	129	135	143	125	184	160	154	137	126	113	84
44 N	QS	2.55	5.63	5.86	8.54	8.52	9.16	9.52	9.11	9.97	5.32	3.31	2.37
126 W	QB	4.32	5.11	4.11	4.72	3.66	3.08	3.29	3.63	5.06	4.51	4.74	5.53
	QE	9.27	7.88	6.21	7.28	5.00	7.84	7.09	7.05	5.40	9.67	11.17	18.87
	QC	7.52	4.46	3.00	4.39	2.72	4.21	3.57	4.37	3.18	4.92	6.09	10.84
	QN	17.24	12.10	9.72	10.44	8.66	14.43	11.90	13.42	8.03	13.69	16.83	27.43
	OBS	30	26	44	35	49	43	43	48	27	33	35	25
44 N	QS	2.39	5.18	6.08	8.54	10.00	9.35	10.83	7.27	8.41	6.32	3.15	1.69
127 W	QB	3.45	4.80	4.10	4.39	4.17	7.39	3.83	3.07	3.90	4.37	3.61	3.50
	QE	11.06	5.84	5.24	9.66	4.65	8.27	5.85	7.06	10.78	20.17	10.59	12.33
	QC	7.26	3.86	3.31	4.30	1.98	3.41	3.13	2.97	4.24	10.46	4.48	8.20
	QN	17.67	9.33	8.55	13.67	6.44	13.24	10.42	10.69	16.37	29.95	14.62	20.21
	OBS	38	30	44	30	41	30	30	46	32	19	36	36
44 N	QS	1.68	3.43	4.72	6.02	6.27	7.37	6.62	7.16	4.36	2.32	1.64	1.52
128 W	QB	2.57	3.19	2.78	2.97	2.51	2.64	2.48	3.07	2.41	1.76	2.01	3.11
	QE	8.84	7.62	7.40	6.15	4.29	5.43	6.29	6.66	4.97	4.72	5.62	7.69
	QC	5.71	4.80	5.06	4.56	2.44	2.30	2.54	2.63	1.95	1.82	2.66	5.84
	QN	14.67	12.13	12.07	9.28	7.02	8.90	10.03	10.06	7.33	5.86	8.07	12.97
	OBS	54	44	70	65	83	58	65	56	90	155	139	52
44 N	QS	1.92	3.00	5.20	4.90	6.29	7.21	7.25	5.85	5.13	2.86	1.94	1.05
129 W	QB	3.32	2.91	3.27	2.11	2.44	2.60	2.51	2.42	2.81	2.33	2.45	2.28
	QE	7.40	7.55	6.78	5.82	5.04	7.41	5.71	5.76	6.83	5.95	6.96	7.96
	QC	5.17	5.02	4.52	3.55	2.65	2.71	2.64	2.19	2.72	2.23	3.29	5.04
	QN	12.42	11.73	11.66	9.18	7.23	9.76	10.57	8.28	9.34	7.87	9.93	12.85
	OBS	59	62	62	86	72	67	73	72	79	106	83	91
44 N	QS	1.55	2.73	4.30	6.49	6.48	7.65	6.08	5.80	4.68	3.07	2.03	1.16
130 W	QB	2.38	2.79	2.79	3.16	2.64	2.73	2.16	2.24	2.61	2.53	2.82	2.50
	QE	7.70	5.40	5.92	6.87	6.22	4.44	5.26	6.10	6.59	9.49	8.50	10.24
	QC	4.99	3.58	3.49	4.84	3.18	2.99	2.20	1.89	2.53	3.69	3.83	4.76
	QN	12.65	8.55	9.00	11.68	9.60	9.25	8.83	8.72	8.78	13.01	12.39	14.82
	OBS	83	78	70	58	78	67	84	66	77	88	77	73
44 N	QS	1.29	2.27	2.87	4.85	4.71	3.84	3.75	3.70	2.93	2.02	1.32	.78
131 W	QB	2.04	2.25	1.82	2.22	1.87	1.34	1.31	1.47	1.48	1.49	1.93	1.65
	QE	5.35	5.05	3.76	4.16	2.89	3.24	3.00	3.33	4.29	5.77	4.89	6.56
	QC	4.21	3.04	2.42	2.65	1.74	1.77	1.33	1.27	1.63	2.33	2.18	3.48
	QN	10.41	7.98	5.86	6.29	4.77	5.17	4.96	5.04	5.59	7.78	7.01	9.96
	OBS	120	105	155	115	156	192	195	198	206	206	146	133
44 N	QS	1.32	2.17	3.75	5.73	5.22	7.23	4.76	5.87	4.99	3.10	1.80	1.07
132 W	QB	2.10	2.16	2.15	2.55	2.02	2.57	1.76	2.62	2.80	2.50	2.41	2.18
	QE	8.03	8.98	7.43	3.99	4.86	5.73	3.57	5.75	6.85	7.84	7.39	9.85
	QC	5.43	4.40	4.52	3.49	2.29	3.58	1.67	1.85	2.13	3.04	4.65	5.68
	QN	13.28	12.80	11.56	8.11	7.47	10.76	6.20	7.21	8.59	10.27	11.88	15.44
	OBS	89	68	78	91	92	78	96	72	66	88	86	81
44 N	QS	1.35	2.82	3.27	6.12	5.45	5.67	5.72	4.89	4.72	2.81	1.86	.95
133 W	QB	2.09	2.85	2.16	3.06	2.27	1.96	2.01	1.92	2.43	2.24	2.72	2.02
	QE	6.39	7.81	6.91	5.13	4.47	5.63	3.88	5.12	7.40	8.44	7.12	7.23
	QC	4.04	4.17	3.76	2.95	2.64	3.01	1.83	1.48	2.30	2.95	3.85	4.10
	QN	10.49	11.83	10.41	7.35	7.77	9.40	5.89	7.06	9.02	10.85	10.78	11.33
	OBS	94	76	43	67	80	83	72	73	67	88	75	89

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
45 N	QS	2.14	3.81	5.80	6.90	8.54	5.79	9.10	6.82	7.79	4.66	2.71	2.31
124 W	QB	4.48	3.51	3.57	3.62	3.40	2.04	3.27	2.76	4.53	3.63	4.02	5.09
	QE	8.61	4.56	4.96	4.57	3.69	3.09	3.48	2.30	6.01	6.15	8.05	7.89
	QC	4.87	3.42	4.36	2.56	2.35	1.61	2.08	1.47	3.86	2.74	3.03	6.47
	QN	14.14	7.76	9.13	7.04	7.68	5.61	8.14	5.72	10.23	8.03	10.39	13.74
	OBS	34	45	48	54	63	109	64	91	37	54	40	25
45 N	QS	1.07	2.09	3.10	3.66	4.44	3.68	4.18	5.37	4.12	2.85	1.54	1.24
125 W	QB	1.91	2.11	2.16	1.85	1.84	1.32	1.47	2.09	2.40	2.25	2.42	3.02
	QE	4.74	3.01	3.63	3.13	3.13	2.66	2.67	3.18	3.56	4.21	3.33	4.86
	QC	3.51	1.99	1.89	1.91	1.42	1.44	1.59	1.82	1.74	1.76	1.72	3.41
	QN	8.23	4.97	5.69	4.74	4.96	4.27	4.90	5.95	5.12	5.54	4.66	8.53
	OBS	139	168	164	164	191	231	232	135	127	156	129	94
45 N	QS	1.70	3.37	4.70	5.89	6.81	6.06	7.57	6.28	4.29	4.38	2.45	1.38
126 W	QB	2.78	2.81	3.57	2.72	2.75	2.18	2.84	2.51	2.76	3.62	3.18	3.26
	QE	6.05	5.06	8.74	6.29	3.97	3.03	6.34	5.28	6.77	7.18	7.97	9.42
	QC	4.43	3.13	5.95	4.11	2.04	1.65	2.82	2.10	2.39	2.37	3.37	5.90
	QN	10.19	8.29	14.78	10.13	7.25	5.75	9.20	7.67	9.25	9.13	10.96	13.94
	OBS	53	75	49	62	73	104	69	69	69	56	52	52
45 N	QS	2.01	3.51	4.04	4.98	7.47	6.05	7.49	6.65	6.33	3.89	2.34	1.34
127 W	QB	3.50	3.36	2.53	2.80	3.11	2.25	2.58	2.85	3.54	2.93	3.13	3.17
	QE	9.98	5.23	5.58	6.27	4.58	4.48	5.69	6.74	8.73	8.50	6.55	13.49
	QC	8.97	3.56	4.13	4.29	2.23	2.27	2.69	2.55	3.83	3.77	3.71	7.03
	QN	17.98	8.27	9.90	10.22	6.57	7.75	9.13	10.13	11.15	11.61	10.52	20.19
	OBS	44	61	74	58	62	52	58	53	47	66	63	38
45 N	QS	1.57	2.78	4.82	6.83	4.82	6.39	7.98	5.72	6.69	3.71	1.96	1.55
128 W	QB	2.89	2.86	3.18	3.21	1.90	2.33	2.96	2.41	3.78	2.73	2.92	3.54
	QE	8.43	6.10	7.42	5.46	3.51	6.08	7.19	4.48	8.30	8.24	6.99	10.24
	QC	4.88	3.30	4.82	4.05	1.87	3.50	3.07	2.05	3.55	3.62	3.39	6.70
	QN	13.37	8.57	12.83	9.79	5.23	10.48	11.18	6.86	11.75	11.49	10.27	16.05
	OBS	55	57	54	55	159	58	53	85	41	75	70	40
45 N	QS	1.38	3.30	3.85	5.81	6.99	6.54	7.01	4.91	4.21	3.72	1.65	.98
129 W	QB	2.28	3.24	2.61	2.78	2.57	2.52	2.52	2.15	2.20	3.14	2.54	2.28
	QE	7.60	5.01	6.61	6.18	5.04	4.07	4.98	5.22	7.38	9.20	7.45	7.56
	QC	4.41	3.75	3.57	4.01	2.58	1.89	3.37	1.90	2.99	3.95	4.18	4.44
	QN	12.12	8.55	9.78	9.57	8.11	6.84	9.15	7.60	10.52	12.65	11.72	11.63
	OBS	67	53	79	64	57	77	68	70	83	67	81	62
45 N	QS	.80	1.11	2.19	2.68	4.03	3.44	3.18	3.87	2.81	1.78	1.10	.65
130 W	QB	1.39	1.23	1.36	1.29	1.58	1.21	1.09	1.55	1.48	1.52	1.39	1.47
	QE	4.12	3.29	3.17	2.67	2.28	2.40	2.53	3.57	3.25	5.51	4.60	5.60
	QC	2.38	1.84	2.00	1.57	1.31	1.19	1.39	1.46	1.10	2.34	1.95	2.92
	QN	6.50	4.98	5.10	3.90	4.35	3.88	4.10	5.08	4.06	7.79	6.32	8.36
	OBS	248	288	280	272	195	205	281	164	245	210	238	210
45 N	QS	1.17	1.81	2.75	4.18	4.15	4.45	3.89	4.43	4.68	2.36	1.52	.81
131 W	QB	1.97	1.82	1.69	2.04	1.71	1.56	1.30	1.71	2.39	1.84	2.04	1.83
	QE	5.32	4.22	3.94	4.36	3.02	2.62	3.32	3.75	5.57	7.23	5.28	6.34
	QC	3.21	2.64	2.48	2.43	1.65	1.78	1.33	1.45	2.19	2.82	2.78	3.28
	QN	8.49	6.67	6.43	6.55	4.90	4.96	5.09	5.94	8.11	9.56	7.84	9.65
	OBS	138	157	160	137	160	148	155	140	115	129	117	148
45 N	QS	1.64	2.48	3.07	4.28	5.44	4.70	5.17	4.58	3.67	2.99	1.63	.95
132 W	QB	2.56	2.28	2.09	2.04	2.15	1.69	1.82	1.81	1.97	2.15	2.28	2.22
	QE	7.64	5.38	4.42	4.05	3.84	3.30	4.46	4.40	5.34	6.82	6.98	8.52
	QC	5.25	3.44	2.92	2.30	2.44	2.08	2.05	1.75	1.96	3.25	4.04	4.10
	QN	12.84	8.42	7.14	6.17	7.05	6.04	7.33	6.54	7.03	9.80	10.84	12.43
	OBS	90	85	113	113	106	116	83	94	108	109	84	92
45 N	QS	2.16	4.01	4.84	8.69	7.68	9.34	8.54	6.60	6.82	3.25	1.81	1.20
133 W	QB	3.58	3.06	3.38	4.04	3.28	3.48	3.16	2.42	3.48	2.32	2.51	2.95
	QE	12.86	9.12	9.54	6.20	4.53	4.65	6.26	11.78	8.28	8.77	11.00	9.63
	QC	9.26	5.49	6.10	4.10	2.39	2.84	3.40	4.18	2.82	4.12	5.30	6.69
	QN	21.74	14.67	14.98	11.36	8.60	7.48	10.99	17.27	11.25	12.59	15.98	16.43
	OBS	42	30	41	43	37	48	40	28	46	60	55	46

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
46 N	QS	.70	1.26	1.97	2.16	2.78	2.72	3.08	2.72	2.11	1.61	.90	.49
124 W	QB	1.46	1.46	1.31	1.13	1.08	.96	1.10	1.15	1.17	1.30	1.24	1.31
	QE	2.04	1.86	1.56	1.51	1.45	1.31	1.41	1.09	1.23	1.62	1.80	2.13
	QC	2.01	1.41	1.09	.98	.95	.74	.83	.59	.68	.88	1.33	1.76
	QN	4.20	3.08	2.70	2.66	3.10	2.82	3.12	2.36	2.48	2.64	3.09	3.96
	OBS	355	376	424	490	456	537	502	512	475	471	433	434
46 N	QS	1.25	2.62	3.12	4.62	5.71	4.25	5.15	5.09	4.39	2.95	1.91	1.50
125 W	QB	2.34	2.58	2.20	2.47	2.33	1.52	1.90	2.06	2.44	2.24	2.79	3.76
	QE	4.39	4.72	4.16	3.55	3.65	3.50	3.51	3.82	4.80	5.88	5.27	7.11
	QC	3.19	3.18	2.42	2.19	1.91	1.56	1.86	1.88	2.31	2.31	2.71	3.86
	QN	7.56	7.73	6.64	5.49	6.01	5.25	5.85	6.07	7.31	7.65	7.79	10.53
	OBS	104	102	119	116	114	173	167	143	125	119	103	64
46 N	QS	1.89	4.46	5.37	8.07	9.76	8.10	7.61	7.37	6.78	5.45	3.02	1.95
126 W	QB	3.09	4.04	3.82	3.97	4.23	2.92	2.64	3.54	3.67	4.33	4.61	4.67
	QE	9.46	6.30	6.55	7.62	7.08	7.11	5.52	6.92	8.88	8.82	10.88	9.09
	QC	6.26	4.05	3.77	3.89	3.56	2.92	2.61	2.86	4.43	4.43	5.31	5.18
	QN	15.10	8.79	10.71	11.43	11.71	11.02	8.60	10.23	13.44	12.08	15.00	13.37
	OBS	41	51	38	40	27	44	58	49	37	45	31	31
46 N	QS	1.44	3.57	4.15	7.09	7.74	7.25	7.64	6.22	6.23	3.58	1.54	1.10
127 W	QB	2.74	3.40	3.28	3.32	3.18	2.69	2.83	2.60	3.36	2.79	2.37	2.95
	QE	8.20	6.51	5.50	4.38	4.19	7.43	5.36	5.40	9.28	9.73	6.71	7.92
	QC	6.12	4.58	4.01	3.28	2.24	3.32	2.72	2.01	2.76	4.05	3.30	5.12
	QN	14.22	11.40	9.83	8.20	8.02	12.01	9.01	7.96	11.54	13.56	10.00	12.76
	OBS	62	55	71	56	60	61	51	61	44	55	85	52
46 N	QS	1.55	2.86	3.82	6.13	8.33	6.75	8.21	5.02	5.73	3.16	1.63	.89
128 W	QB	2.55	3.19	2.52	3.13	3.34	2.40	2.94	2.26	2.95	2.89	2.82	2.37
	QE	6.49	5.04	5.87	5.59	4.50	4.64	4.49	4.90	7.27	9.51	8.15	7.09
	QC	4.40	3.12	3.40	3.54	2.12	2.57	2.59	2.37	2.82	4.57	3.42	4.53
	QN	10.26	7.76	9.25	8.65	7.58	8.77	8.38	7.73	10.30	14.07	11.65	11.34
	OBS	75	59	88	54	48	67	57	55	57	68	71	83
46 N	QS	1.17	2.12	3.49	5.61	6.88	6.77	7.68	5.63	4.69	3.64	1.93	.94
129 W	QB	2.19	2.55	2.38	2.75	2.66	2.60	2.86	2.33	2.57	2.74	2.76	2.18
	QE	6.41	5.86	5.18	4.23	4.03	4.76	5.19	5.83	7.64	8.05	7.45	6.23
	QC	5.02	4.04	4.09	3.10	2.40	3.08	2.91	2.58	2.85	3.18	3.83	3.93
	QN	10.91	9.48	9.00	7.46	7.37	7.90	7.42	9.12	10.93	10.89	10.86	10.19
	OBS	81	74	90	82	67	72	58	74	71	68	69	87
46 N	QS	1.35	2.57	3.33	5.20	5.88	5.23	5.36	4.65	4.91	3.13	1.73	.87
130 W	QB	2.45	2.64	2.18	2.80	2.34	1.97	1.86	1.96	2.74	2.50	2.55	2.17
	QE	6.56	5.92	5.97	5.43	3.87	4.50	3.49	5.45	6.26	7.34	6.74	7.20
	QC	5.13	3.68	3.72	3.41	2.67	2.17	2.14	2.90	2.33	3.20	3.83	4.21
	QN	11.43	9.28	9.78	8.69	6.83	7.13	6.62	8.18	8.85	10.17	10.60	11.12
	OBS	80	70	115	77	87	108	85	81	79	81	90	88
46 N	QS	1.26	2.07	3.73	4.70	5.77	5.54	4.80	4.12	4.91	2.68	1.43	.84
131 W	QB	2.23	2.11	2.52	2.36	2.43	1.94	1.64	1.64	2.65	2.15	2.06	2.12
	QE	5.99	4.75	5.27	4.57	3.79	3.29	3.95	3.53	6.26	8.70	7.30	7.22
	QC	4.42	3.30	4.58	3.03	2.30	2.34	2.03	1.88	2.86	3.81	3.47	4.23
	QN	10.16	7.44	9.93	6.69	6.90	6.71	6.76	5.60	8.95	12.10	10.65	11.49
	OBS	85	65	74	88	89	100	84	101	92	90	107	93
46 N	QS	1.36	1.85	3.19	3.66	5.31	5.17	5.38	4.16	4.52	3.15	1.97	.79
132 W	QB	2.18	1.92	2.07	1.72	2.16	1.75	1.92	1.83	2.34	2.50	2.50	2.00
	QE	4.71	5.20	3.73	2.75	3.53	3.65	4.38	6.08	6.03	7.27	8.72	7.15
	QC	3.42	3.52	3.01	1.84	2.13	2.57	2.53	1.87	2.61	3.22	4.43	4.29
	QN	8.03	8.23	6.64	4.68	6.82	6.83	7.10	7.81	8.58	10.20	12.79	11.74
	OBS	128	108	146	165	127	85	76	92	103	86	73	80
46 N	QS	1.14	2.95	3.33	5.63	5.51	6.40	6.46	5.25	4.54	2.83	2.02	.84
133 W	QB	2.06	2.90	2.21	2.80	2.20	2.33	2.19	2.07	2.66	2.35	2.73	2.07
	QE	6.52	6.87	5.93	5.31	5.17	4.37	4.88	5.11	7.75	8.87	9.12	8.84
	QC	4.66	4.83	3.88	3.50	3.36	2.24	3.11	2.97	3.18	3.63	5.56	5.51
	QN	11.18	11.59	9.63	8.55	9.02	7.03	9.29	8.97	10.16	12.28	14.10	14.16
	OBS	80	65	70	72	63	61	56	69	66	85	70	79

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
47 N	QS	2.87	6.08	10.44	11.57	18.08	14.52	16.78	16.98	14.72	6.77	1.42	2.65
124 W	QB	9.06	6.55	7.42	5.67	7.11	4.99	6.67	7.30	8.36	5.67	2.31	7.43
	QE	8.98	9.17	14.71	7.59	5.06	5.91	10.61	10.83	7.22	8.35	4.32	12.42
	QC	9.57	8.29	5.04	3.93	2.72	3.46	6.66	6.20	2.72	2.74	2.18	5.80
	QN	19.77	16.10	20.80	10.67	15.64	12.06	17.62	21.88	13.38	11.04	6.10	10.69
	OBS	12	19	8	21	14	16	16	13	13	24	98	7
47 N	QS	1.27	2.76	3.11	4.33	6.23	4.84	5.69	5.84	4.69	2.75	1.42	.94
125 W	QB	2.22	2.91	2.23	2.28	2.53	1.76	2.14	2.32	2.83	2.52	2.25	2.91
	QE	4.74	5.40	4.04	4.04	3.60	3.31	2.79	3.60	3.94	4.83	3.66	6.09
	QC	4.19	3.81	2.67	2.88	1.83	1.41	1.44	1.76	1.95	1.65	2.41	4.12
	QN	8.89	9.00	6.92	6.59	5.92	5.30	5.12	6.56	6.00	6.32	5.80	9.80
	OBS	104	101	122	110	101	168	138	110	94	115	115	70
47 N	QS	1.36	3.01	3.86	4.82	5.93	6.29	7.53	5.64	5.50	3.98	1.82	1.12
126 W	QB	2.65	3.02	2.94	2.42	2.56	2.41	2.93	2.54	3.11	3.21	2.60	3.12
	QE	6.74	4.94	6.34	4.50	4.01	5.27	3.78	4.63	5.71	6.88	5.12	6.28
	QC	4.66	3.35	3.57	2.48	2.01	3.16	2.47	2.03	2.45	3.23	2.84	3.65
	QN	11.32	8.53	9.10	7.21	6.28	7.83	8.06	7.27	8.32	9.23	7.75	10.12
	OBS	79	76	64	85	84	76	74	77	78	65	84	65
47 N	QS	1.18	2.70	3.18	5.12	5.93	4.60	6.76	5.28	4.06	3.51	1.73	.73
127 W	QB	2.59	2.98	2.42	2.44	2.36	1.71	2.51	2.25	2.35	3.01	2.60	2.10
	QE	6.43	5.40	4.90	4.20	3.34	4.20	4.63	5.62	5.59	6.33	4.93	6.18
	QC	4.00	4.21	2.77	2.80	1.84	2.22	2.31	2.61	2.13	2.98	3.34	4.26
	QN	9.95	9.34	7.81	7.35	6.29	5.98	7.63	8.11	7.77	8.40	8.40	9.84
	OBS	90	84	107	89	102	107	84	76	97	76	89	100
47 N	QS	1.40	2.49	3.48	4.46	6.33	6.13	7.79	5.80	3.82	2.06	1.78	.81
128 W	QB	2.55	2.49	2.55	2.36	2.59	2.18	2.75	2.31	2.32	1.75	2.47	2.31
	QE	6.91	5.90	4.93	5.47	3.85	4.49	4.37	4.57	6.19	5.33	6.59	7.59
	QC	5.44	4.21	2.89	3.34	2.72	2.36	2.12	2.00	2.30	2.32	3.28	5.20
	QN	12.25	9.90	7.71	8.32	7.16	7.47	8.46	7.06	8.87	7.21	9.54	12.78
	OBS	75	72	106	77	82	70	59	80	111	156	91	84
47 N	QS	2.05	3.34	5.09	5.69	7.64	7.24	6.38	6.32	6.44	2.34	2.13	.91
129 W	QB	3.51	3.27	3.36	2.67	3.22	2.67	2.17	2.54	3.54	1.92	2.89	2.59
	QE	9.50	7.75	5.77	4.81	4.49	4.24	4.24	7.53	6.42	6.50	7.05	8.12
	QC	6.85	5.62	4.25	3.49	2.65	3.33	2.93	3.67	2.73	2.42	3.54	4.88
	QN	16.21	12.94	9.57	8.58	8.09	9.03	8.70	10.73	9.16	8.60	10.18	12.97
	OBS	48	50	56	60	59	61	63	49	55	117	68	61
47 N	QS	1.09	1.52	2.42	3.35	3.77	4.68	3.73	3.23	3.29	2.71	2.05	.58
130 W	QB	1.94	1.64	1.71	1.57	1.59	1.62	1.24	1.28	1.72	2.13	3.34	1.68
	QE	4.65	5.46	4.76	2.87	2.64	3.01	2.52	3.54	4.34	11.13	11.32	4.63
	QC	3.96	3.24	3.02	1.73	1.58	1.84	1.21	1.68	1.66	4.16	5.86	2.63
	QN	8.27	8.41	7.87	4.02	4.33	5.24	4.54	5.36	5.80	14.62	16.25	6.95
	OBS	138	148	148	141	113	128	157	136	146	87	47	143
47 N	QS	1.14	2.33	3.11	4.11	5.29	3.62	4.11	3.61	2.99	2.18	1.46	.52
131 W	QB	1.97	2.46	2.01	1.92	2.13	1.31	1.41	1.43	1.60	1.93	2.00	1.52
	QE	4.74	5.81	4.06	3.93	2.45	3.07	2.57	3.76	5.98	7.52	6.45	5.49
	QC	3.57	3.38	2.99	2.11	1.86	1.86	1.60	1.56	2.49	3.44	2.72	3.58
	QN	8.12	8.85	7.04	6.03	5.29	5.44	4.64	5.74	8.68	10.57	8.70	8.96
	OBS	125	79	105	120	112	162	142	180	170	145	110	150
47 N	QS	1.15	1.89	3.34	5.22	4.84	3.23	3.36	3.83	3.70	1.83	1.15	.63
132 W	QB	2.08	2.25	2.14	2.41	1.89	1.16	1.18	1.52	2.06	1.78	1.69	1.89
	QE	6.52	4.57	5.22	4.18	2.52	2.78	2.67	3.32	4.15	7.12	5.92	6.59
	QC	4.64	2.94	3.82	2.84	1.53	1.76	1.23	1.59	1.85	3.36	2.79	3.95
	QN	10.90	7.30	9.31	7.08	4.75	4.72	4.59	5.06	5.31	10.14	8.66	10.61
	OBS	99	113	103	100	143	211	149	142	134	143	148	119
47 N	QS	1.43	2.87	4.05	6.56	6.13	4.99	5.52	5.08	5.40	2.90	1.67	1.08
133 W	QB	2.42	2.73	2.87	3.08	2.51	1.74	1.83	2.17	2.76	2.64	2.42	2.92
	QE	6.18	7.06	7.15	4.93	5.07	5.62	4.50	5.30	5.66	9.60	10.85	8.76
	QC	5.40	3.92	4.93	4.11	3.88	3.60	2.61	2.42	2.49	4.48	5.98	5.80
	QN	11.26	10.48	11.83	8.33	8.77	9.48	7.35	7.30	7.69	13.96	17.29	14.53
	OBS	48	60	49	57	50	60	42	66	59	71	69	61

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
48 N	QS	.39	1.25	1.68	2.14	2.78	2.96	2.98	2.81	2.06	1.46	.87	.41
125 W	QB	1.01	1.30	1.24	1.13	1.17	1.10	1.14	1.18	1.26	1.40	1.35	1.42
	QE	2.39	2.42	1.92	1.74	1.34	1.21	1.68	2.02	1.98	2.34	2.76	3.00
	QC	2.25	1.85	1.64	1.48	.80	.84	1.07	1.22	1.21	1.47	2.21	2.75
	QN	4.60	4.18	3.67	3.54	2.74	2.76	3.43	3.76	3.48	3.83	4.91	5.67
	OBS	514	458	497	496	439	452	500	455	458	428	390	365
48 N	QS	1.05	2.65	3.93	4.89	6.20	6.30	6.51	5.94	4.64	2.22	1.22	.61
126 W	QB	2.58	2.96	2.82	2.45	2.46	2.31	2.43	2.53	2.65	1.99	2.00	1.99
	QE	4.92	4.96	3.83	4.85	3.71	3.41	3.55	3.55	4.64	4.50	5.27	5.06
	QC	3.98	3.05	2.94	2.45	1.84	2.10	1.40	1.72	1.98	2.52	3.53	3.39
	QN	9.19	7.74	6.53	7.02	5.99	6.84	6.03	5.88	7.02	6.92	8.69	8.53
	OBS	103	89	102	85	92	98	94	97	94	152	149	119
48 N	QS	1.20	2.78	4.27	6.32	6.16	7.10	7.60	6.45	4.71	3.78	1.45	.71
127 W	QB	2.42	3.00	3.34	3.57	2.59	2.68	2.92	2.89	2.47	3.07	2.61	2.27
	QE	5.39	5.36	5.99	6.06	4.93	3.47	4.95	5.21	4.75	7.92	5.46	7.50
	QC	4.07	3.92	3.38	4.13	3.96	2.17	2.69	2.74	1.91	3.86	2.79	4.38
	QN	9.31	8.72	9.98	9.00	9.10	6.23	8.52	7.72	7.16	11.42	8.61	11.28
	OBS	83	62	67	54	78	75	68	67	99	66	106	70
48 N	QS	1.22	2.43	3.92	4.97	6.23	6.26	6.72	6.09	5.29	2.84	1.78	.84
128 W	QB	2.36	2.87	3.04	2.51	2.48	2.35	2.38	2.47	2.74	2.68	2.79	2.50
	QE	7.49	5.40	3.91	3.70	3.74	3.92	5.35	4.94	6.07	10.13	6.25	6.41
	QC	4.67	4.56	2.46	3.02	1.91	2.22	3.40	2.35	3.25	4.85	3.51	4.25
	QN	12.14	10.88	6.11	7.04	5.72	6.87	9.30	7.83	8.76	14.67	9.90	10.38
	OBS	63	78	84	82	84	73	63	67	83	72	73	80
48 N	QS	1.07	2.43	3.85	6.33	5.41	6.75	7.64	5.17	5.20	3.18	1.48	.73
129 W	QB	2.08	2.64	2.71	3.01	2.23	2.50	2.57	2.02	2.74	2.66	2.24	2.36
	QE	7.90	5.71	6.04	4.42	3.55	5.11	5.17	4.95	5.18	6.88	7.30	6.93
	QC	5.67	4.33	3.77	3.03	2.17	2.86	2.74	2.56	2.41	3.11	4.85	4.98
	QN	13.42	9.70	9.83	8.25	6.55	8.23	8.70	8.28	7.11	9.17	11.81	11.92
	OBS	69	67	63	56	86	71	65	74	81	62	84	75
48 N	QS	1.27	2.55	3.83	5.53	6.91	5.85	6.14	4.31	3.48	2.76	1.29	.65
130 W	QB	2.44	2.96	2.91	3.06	2.90	2.14	2.31	1.71	1.98	2.46	1.95	2.17
	QE	7.53	6.21	4.82	3.58	3.60	4.00	4.69	4.31	4.42	6.95	6.18	8.49
	QC	5.14	4.63	3.92	2.92	2.68	2.77	2.06	2.42	2.46	3.37	3.24	5.26
	QN	12.46	10.46	9.30	6.93	6.93	6.60	7.71	7.16	7.06	10.02	9.32	13.57
	OBS	73	62	75	70	72	72	69	90	116	79	84	85
48 N	QS	1.30	2.76	3.54	4.60	5.07	5.23	5.11	3.66	3.85	2.35	1.25	.72
131 W	QB	2.23	2.92	2.67	2.30	2.08	1.80	1.85	1.68	2.17	2.05	2.25	2.19
	QE	6.92	4.87	4.79	3.81	2.89	3.02	3.03	4.18	4.97	7.15	6.94	6.61
	QC	5.49	3.84	2.93	2.68	2.19	1.73	2.19	2.09	2.24	3.29	3.18	4.91
	QN	12.41	8.40	7.88	5.95	5.98	5.45	6.21	6.63	7.34	10.23	9.96	11.43
	OBS	78	77	77	91	116	96	105	98	111	99	95	95
48 N	QS	.79	1.40	2.28	3.97	3.80	4.05	3.47	2.99	3.36	2.62	1.12	.51
132 W	QB	1.49	1.46	1.64	1.94	1.64	1.44	1.20	1.06	1.77	2.40	1.87	1.61
	QE	3.97	3.62	2.98	2.88	2.02	3.23	2.95	3.34	4.36	8.66	5.93	4.60
	QC	3.08	2.45	2.42	1.85	1.37	2.08	1.75	1.85	1.76	3.50	3.35	3.00
	QN	7.03	5.84	5.28	4.88	3.85	5.74	4.77	5.22	5.97	12.03	9.44	7.60
	OBS	169	157	178	157	196	117	122	114	134	98	131	168
48 N	QS	1.25	2.58	4.12	5.31	5.49	5.06	4.88	4.15	3.73	2.49	1.18	.63
133 W	QB	2.51	3.12	2.65	2.69	2.27	1.84	1.75	1.67	2.17	2.45	1.99	2.02
	QE	6.75	7.94	4.80	4.36	3.03	3.30	3.28	4.63	6.16	8.04	6.49	6.48
	QC	4.49	5.48	3.28	3.43	2.24	2.57	1.94	2.32	2.76	3.68	4.15	4.36
	QN	10.76	13.43	7.97	7.76	6.53	6.37	5.91	7.21	8.81	11.64	10.30	10.83
	OBS	72	55	71	88	84	82	91	74	96	94	105	108
48 N	QS	1.54	2.80	4.40	5.24	5.81	5.71	5.91	4.84	5.49	2.74	1.47	.71
134 W	QB	3.39	3.02	2.91	2.79	2.32	1.89	2.07	2.16	3.19	2.35	2.17	2.15
	QE	8.69	5.98	6.02	4.29	3.48	4.47	3.79	5.09	10.26	8.17	8.55	6.71
	QC	6.95	4.94	4.35	3.91	3.09	3.43	3.15	2.88	4.16	3.55	4.45	6.01
	QN	15.87	10.58	10.55	8.51	6.71	9.08	7.52	7.95	14.34	11.25	12.90	12.40
	OBS	43	64	60	64	77	66	58	62	49	70	86	78

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
49 N	QS	1.83	2.90	5.52	6.80	7.40	8.10	7.52	7.18	5.11	3.92	1.97	1.10
126 W	QB	3.73	4.09	4.30	3.83	3.10	3.03	2.82	3.34	3.02	3.78	3.69	3.70
	QE	11.26	6.87	6.90	4.82	4.17	4.04	2.55	3.68	3.74	8.82	5.73	7.93
	QC	8.29	5.53	5.67	3.43	2.70	2.02	2.65	2.74	2.08	3.22	3.93	5.57
	QN	20.31	11.97	12.45	8.15	7.58	7.39	6.57	7.17	6.06	12.15	9.66	13.27
	OBS	37	38	37	57	63	67	89	70	89	53	55	46
49 N	QS	1.42	2.02	3.96	5.29	5.70	6.50	5.73	4.99	4.26	2.54	1.49	.74
127 W	QB	3.22	3.11	2.70	2.89	2.39	2.44	2.19	2.19	2.43	2.34	2.25	2.66
	QE	5.40	5.96	4.62	4.96	3.07	3.13	2.65	3.35	4.61	4.66	4.36	5.58
	QC	4.04	3.61	3.24	2.87	2.08	2.96	1.75	2.36	2.94	2.10	3.35	3.34
	QN	9.63	9.53	8.01	7.86	5.63	6.76	5.27	6.41	8.09	6.88	7.32	9.09
	OBS	74	67	87	92	109	104	140	120	127	109	106	89
49 N	QS	.92	2.36	2.96	4.61	3.77	5.07	4.71	4.16	3.38	2.63	1.05	.70
128 W	QB	2.12	2.71	2.13	2.27	1.57	1.84	1.78	1.69	1.96	2.28	2.04	2.48
	QE	4.96	4.77	3.72	4.48	2.18	2.86	2.60	2.85	4.15	5.41	4.71	5.37
	QC	3.43	3.54	2.67	2.59	1.46	2.10	1.54	1.42	1.90	2.09	2.74	3.85
	QN	8.36	8.38	6.54	6.51	3.95	5.92	4.75	4.70	6.25	6.69	7.47	9.39
	OBS	103	89	116	109	219	148	174	187	161	112	141	95
49 N	QS	1.24	1.83	2.98	3.96	4.10	4.83	4.46	4.09	3.31	2.48	1.14	.58
129 W	QB	2.59	2.19	2.01	2.05	1.70	1.75	1.62	1.67	2.00	2.06	1.89	1.88
	QE	5.61	4.06	3.74	3.02	2.65	3.18	3.14	3.05	4.48	5.62	4.30	4.89
	QC	4.69	2.53	2.40	1.98	1.62	1.78	1.82	1.38	1.82	2.78	2.64	3.75
	QN	10.55	6.50	6.14	5.24	4.35	5.96	5.45	4.62	6.47	8.01	6.95	8.47
	OBS	103	110	127	137	155	130	144	165	142	129	138	111
49 N	QS	.77	1.66	2.64	3.64	4.01	4.12	3.92	3.42	2.84	1.98	.97	.53
130 W	QB	1.73	1.89	1.91	1.77	1.68	1.49	1.42	1.56	1.57	1.79	1.70	1.82
	QE	4.43	3.94	3.18	2.87	2.23	2.42	2.61	3.13	3.45	4.61	4.10	4.45
	QC	3.04	2.83	2.04	1.91	1.54	1.36	1.59	1.58	1.56	2.18	2.39	2.68
	QN	7.53	6.61	5.41	4.96	3.90	4.57	4.78	4.72	4.80	6.75	6.34	7.10
	OBS	169	155	166	168	167	155	165	188	190	159	187	161
49 N	QS	.60	1.30	2.17	2.80	4.02	2.94	2.96	3.35	2.49	1.71	.91	.45
131 W	QB	1.33	1.62	1.57	1.37	1.68	1.03	1.03	1.34	1.42	1.58	1.57	1.54
	QE	3.65	3.40	3.00	2.17	2.32	1.56	2.11	2.83	3.18	4.09	4.48	3.49
	QC	2.68	2.29	1.90	1.73	1.88	.87	1.12	1.52	1.34	2.08	2.41	2.27
	QN	6.29	5.59	4.99	3.83	4.37	3.10	3.63	4.67	4.32	5.99	6.95	5.81
	OBS	221	203	225	239	178	281	237	190	235	204	203	217
49 N	QS	.84	1.88	3.00	4.67	4.37	4.20	4.19	3.78	2.80	2.14	1.19	.48
132 W	QB	2.02	1.99	2.01	2.15	1.77	1.48	1.52	1.64	1.68	1.87	1.94	1.68
	QE	5.57	4.73	4.51	3.36	2.47	3.39	2.31	3.98	4.27	5.72	5.19	4.98
	QC	4.19	3.70	2.46	2.25	2.11	1.65	1.88	1.86	2.13	2.95	3.18	3.77
	QN	9.76	8.11	6.93	5.96	5.16	5.65	4.28	5.56	6.12	8.43	7.92	8.68
	OBS	113	103	114	106	133	116	139	133	141	144	135	133
49 N	QS	.76	1.80	2.91	3.27	3.92	3.77	3.91	3.30	2.91	1.98	1.06	.60
133 W	QB	1.85	2.30	1.96	1.69	1.74	1.34	1.41	1.29	1.72	1.87	1.77	2.05
	QE	6.38	4.87	4.56	2.97	3.33	2.82	2.79	3.17	3.63	5.65	4.68	5.95
	QC	4.99	3.29	2.62	2.31	1.78	1.86	1.87	1.42	1.51	2.80	2.86	4.50
	QN	11.23	8.29	6.69	4.92	5.02	5.16	5.37	4.91	5.03	7.97	7.59	10.33
	OBS	117	97	136	150	148	150	122	170	170	142	163	120
49 N	QS	.84	1.82	2.85	3.94	3.99	3.57	3.70	2.73	2.79	1.81	.95	.49
134 W	QB	1.89	2.17	2.15	2.03	1.69	1.34	1.38	1.16	1.67	1.66	1.64	1.66
	QE	5.26	5.06	4.13	3.24	2.44	2.65	2.57	2.90	3.88	5.74	5.26	5.56
	QC	4.41	3.31	2.69	2.19	1.86	1.87	1.52	1.53	1.95	2.45	3.13	3.62
	QN	9.46	8.32	6.83	5.45	4.67	4.68	4.32	4.11	5.52	7.91	8.35	9.25
	OBS	130	101	125	142	160	146	139	170	179	174	164	135
49 N	QS	.83	1.73	2.71	3.62	4.12	3.53	3.73	2.99	2.82	1.80	.90	.54
135 W	QB	1.49	1.94	1.80	1.83	1.63	1.29	1.41	1.23	1.63	1.67	1.53	1.78
	QE	4.86	4.08	4.00	2.73	2.69	2.70	2.53	3.11	4.19	5.51	4.45	4.84
	QC	4.21	2.60	2.55	2.13	2.33	2.73	1.65	1.54	2.13	2.70	2.80	3.09
	QN	9.19	6.28	6.42	4.48	5.74	5.45	4.27	4.64	5.96	7.94	7.20	7.76
	OBS	102	102	133	139	138	109	111	138	160	138	186	154

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
50 N	QS	3.20	4.10	6.76	9.30	21.86	9.71	17.97	11.90	11.06	6.95	3.67	1.63
127 W	QB	10.60	3.95	9.04	6.18	10.41	7.78	6.20	4.98	5.12	6.75	7.43	6.53
	QE	16.33	14.81	14.39	13.24	20.80	7.95	8.43	4.33	7.45	12.31	22.54	13.96
	QC	14.91	17.70	14.60	6.13	4.91	8.21	7.52	4.06	6.01	6.12	18.66	5.75
	QN	36.71	32.07	28.12	15.99	24.61	17.03	20.13	3.30	13.36	17.29	39.16	11.79
	OBS	9	8	13	18	11	12	19	24	23	14	12	10
50 N	QS	1.35	4.55	5.27	8.03	10.04	8.41	9.07	8.98	7.24	4.33	1.47	.96
128 W	QB	4.04	5.01	3.60	4.24	3.93	3.03	3.50	3.85	3.85	3.84	3.33	4.19
	QE	8.64	10.75	6.97	5.60	5.00	5.78	5.86	6.62	5.46	7.96	4.85	11.08
	QC	7.63	6.85	3.10	3.61	4.36	3.19	2.94	4.08	3.73	5.21	2.87	6.14
	QN	16.56	16.43	10.12	9.22	10.56	10.69	9.82	11.05	9.75	13.05	7.84	18.39
	OBS	32	23	35	41	40	61	59	46	42	49	56	35
50 N	QS	1.39	2.29	3.92	5.04	6.34	6.72	6.64	4.89	4.40	3.36	1.41	.73
129 W	QB	3.37	2.89	3.01	3.13	2.62	2.41	2.52	2.05	2.59	3.16	2.92	3.02
	QE	6.87	8.15	6.92	6.21	4.74	5.10	4.19	4.28	5.44	6.39	5.78	7.27
	QC	4.60	5.12	4.95	4.41	2.31	3.40	2.47	2.19	2.94	3.34	3.97	4.84
	QN	11.45	12.53	11.94	10.50	7.60	9.82	7.57	7.43	8.31	8.89	9.64	11.84
	OBS	55	51	62	71	84	62	97	102	81	69	75	49
50 N	QS	1.03	2.09	3.77	5.04	5.64	5.26	5.34	4.69	3.71	2.86	1.23	.67
130 W	QB	2.99	2.59	2.74	2.63	2.46	1.90	1.87	2.00	2.24	2.42	2.68	2.90
	QE	7.19	6.25	6.51	5.45	3.21	3.07	3.04	4.42	4.15	6.76	6.48	7.42
	QC	5.79	3.93	4.52	3.34	2.05	1.96	1.55	2.67	2.15	3.63	3.94	4.84
	QN	13.54	10.02	11.33	9.13	6.13	6.44	5.88	7.04	6.02	10.06	10.39	12.50
	OBS	61	74	61	84	95	108	118	93	106	86	74	54
50 N	QS	1.04	2.70	3.33	3.84	4.75	4.63	4.06	3.49	3.07	2.37	1.19	.69
131 W	QB	2.64	3.02	2.28	1.97	2.11	1.71	1.45	1.50	1.83	2.00	2.17	2.61
	QE	5.96	5.69	6.52	3.46	2.91	2.99	2.22	3.18	4.57	6.09	5.27	5.65
	QC	4.68	3.62	4.38	2.20	2.06	1.93	1.66	1.87	2.02	2.75	3.64	4.25
	QN	10.78	9.17	10.95	5.84	4.99	5.40	4.64	5.30	6.27	8.56	8.63	10.07
	OBS	85	74	84	121	127	113	158	146	143	109	108	75
50 N	QS	1.11	2.04	3.24	4.68	5.09	4.21	3.80	4.01	3.11	2.32	1.27	.71
132 W	QB	2.38	2.43	2.38	2.35	2.14	1.51	1.41	1.72	2.06	2.34	1.95	3.07
	QE	7.71	4.90	4.52	2.79	2.94	3.21	2.35	3.51	3.61	6.89	6.09	6.54
	QC	5.81	4.58	3.48	2.67	2.18	1.88	1.21	1.90	1.73	3.24	3.92	4.82
	QN	13.87	9.29	8.20	6.09	5.68	5.64	3.75	5.63	5.17	9.83	9.75	11.34
	OBS	66	74	84	98	114	110	140	136	132	84	101	64
50 N	QS	.97	2.66	3.54	4.41	5.05	4.39	4.37	3.93	3.53	2.57	1.12	.63
133 W	QB	2.43	2.51	2.52	2.25	2.19	1.57	1.56	1.63	2.11	2.27	2.19	2.28
	QE	6.40	5.62	5.74	3.93	3.14	2.93	2.31	3.48	5.50	6.71	6.18	6.89
	QC	5.04	4.73	3.54	3.00	2.25	2.44	1.76	1.76	3.21	2.61	4.25	5.05
	QN	11.72	3.83	9.02	7.36	5.41	5.86	5.20	5.60	8.72	9.03	10.28	12.01
	OBS	64	70	64	107	103	108	114	123	103	93	78	74
50 N	QS	.66	1.50	2.56	3.25	3.68	2.72	3.87	3.15	3.24	2.34	.93	.44
134 W	QB	1.69	1.73	1.63	1.66	1.61	.96	1.44	1.36	1.99	2.10	1.58	1.80
	QE	4.56	3.36	3.27	2.49	2.84	2.15	1.85	2.79	4.55	7.25	5.03	5.68
	QC	3.44	2.68	1.97	1.91	1.97	1.52	1.16	1.34	2.23	3.18	3.30	3.98
	QN	8.08	5.81	5.41	4.34	4.90	3.82	3.67	4.34	6.39	9.70	8.25	9.94
	OBS	166	141	160	168	160	208	162	178	114	87	170	139
50 N	QS	.78	1.45	2.82	4.20	4.10	3.17	3.26	3.20	1.70	1.80	.95	.46
135 W	QB	2.01	1.98	1.98	2.10	1.66	1.11	1.20	1.36	1.15	1.80	1.67	1.86
	QE	5.71	4.38	5.58	3.85	2.79	2.60	2.27	3.28	2.65	6.12	5.59	5.42
	QC	4.78	3.34	3.22	2.90	2.07	1.61	1.67	1.54	1.06	3.19	3.25	3.80
	QN	10.47	7.56	8.65	6.99	4.93	4.43	4.31	5.00	3.52	9.18	8.92	9.12
	OBS	104	97	111	123	149	156	131	140	375	139	145	116
50 N	QS	.49	1.11	1.37	1.65	2.04	1.88	2.16	1.96	2.18	1.23	.51	.23
136 W	QB	1.17	1.32	1.05	.89	.89	.67	.79	.84	1.31	1.09	1.00	.95
	QE	2.80	2.76	2.00	1.58	1.77	1.76	1.34	2.09	3.22	3.79	2.89	2.78
	QC	1.94	2.14	1.39	.96	1.05	1.18	1.13	1.02	1.50	1.80	1.84	1.89
	QN	4.82	4.76	3.35	2.23	2.73	2.94	2.73	3.09	4.31	5.52	4.65	4.70
	OBS	344	328	431	604	487	445	277	312	270	349	431	445

APPENDIX III

Monthly Mean Surface Atmospheric Properties

The following tables list the long-term monthly mean surface atmospheric properties approximately corresponding to the distributions of monthly mean heat exchange components displayed in Appendix I. Each page contains values for 10 1° squares. Within each group of 10, all 1° squares are defined by a common latitude. The first set of values corresponds to the 1° square adjacent to the coast. The final tabulations refer to the 1° square farthest from the coast.

Monthly mean properties are tabulated for windspeed (SPD, m/s), surface air temperature (AIR, °C), sea surface temperature (SEA, °C), vapor pressure of the air (VPA, mbar), saturation vapor pressure at the sea surface temperature (VPS, mbar), and total cloud amount (CLD. %). These estimates of monthly mean surface properties were used to calculate the heat exchange components, $Q_N(M)$, for comparisons with the heat exchange values computed from individual reports, $Q_N(I)$, shown in Figures 5, 6, and 7, and in Table 1.

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
21 N	SPD	5.24	4.20	4.97	6.54	5.87	5.41	4.26	4.40	4.98	5.22	4.39	4.37
111 W	AIR	21.15	21.30	21.26	20.79	21.14	22.06	25.26	27.06	27.05	26.40	24.69	23.13
	SEA	23.07	22.86	22.26	21.84	21.95	22.55	25.64	27.43	27.58	27.26	26.17	24.59
	VPA	18.68	18.53	18.40	19.00	20.01	21.62	27.33	28.84	29.23	27.29	23.50	21.33
	VPS	28.33	27.95	26.94	26.27	26.45	27.51	33.14	36.65	37.04	36.30	34.04	31.05
	CLD	57.50	40.56	42.85	48.46	45.37	52.83	46.14	47.53	46.65	45.89	48.07	45.52
21 N	SPD	4.47	4.65	4.85	6.69	5.87	5.22	4.99	5.29	6.34	4.79	4.74	4.62
112 W	AIR	21.59	21.10	20.28	20.26	21.02	21.49	24.63	26.17	26.23	25.57	24.20	22.09
	SEA	22.90	22.29	21.45	21.95	21.90	22.15	24.79	26.96	26.94	26.43	25.51	24.19
	VPA	19.00	18.39	17.38	18.46	19.68	20.17	25.88	27.50	27.92	25.10	23.94	19.77
	VPS	28.04	26.98	25.66	26.43	26.44	26.75	31.56	35.68	35.74	34.65	32.74	30.37
	CLD	47.72	45.83	51.01	52.08	51.41	54.82	45.93	51.95	59.59	46.07	45.98	52.18
21 N	SPD	5.12	5.79	5.69	5.71	6.26	5.76	4.66	5.24	5.94	4.40	5.75	5.27
113 W	AIR	21.57	20.33	19.70	19.92	20.85	21.61	24.73	26.03	25.91	25.59	23.56	22.47
	SEA	23.02	21.58	21.92	21.73	22.23	22.19	24.53	26.21	26.61	25.85	24.92	24.73
	VPA	18.71	18.39	17.22	17.87	19.24	19.97	25.88	27.57	28.19	26.36	23.25	19.47
	VPS	28.20	25.94	26.39	26.11	26.93	26.92	30.92	34.14	35.06	33.44	31.65	31.31
	CLD	46.73	61.32	40.17	60.48	54.77	65.08	59.48	52.38	62.96	45.65	52.17	48.75
21 N	SPD	5.77	6.54	5.21	6.86	6.69	5.27	6.33	5.90	7.18	3.90	4.80	4.82
114 W	AIR	20.32	20.69	20.16	21.14	20.28	20.82	23.92	25.11	24.47	24.24	23.08	21.47
	SEA	22.09	21.35	21.10	21.95	21.14	22.22	24.21	25.94	25.77	24.62	23.87	23.29
	VPA	17.28	19.31	17.55	19.77	18.30	20.44	24.90	26.05	26.69	22.86	22.62	18.76
	VPS	26.69	25.61	25.17	26.42	25.33	27.31	30.40	33.67	33.26	31.09	29.71	28.75
	CLD	58.69	58.87	62.93	45.23	64.28	60.93	69.37	47.11	67.85	46.71	46.42	58.85
21 N	SPD	5.42	5.80	5.78	6.73	5.53	4.66	3.57	4.37	5.37	5.04	6.09	5.93
115 W	AIR	19.92	20.95	19.40	20.30	19.91	21.25	25.38	25.57	25.23	23.90	22.50	21.95
	SEA	22.37	21.92	20.99	21.23	21.70	22.55	24.12	26.12	26.04	25.70	23.84	23.94
	VPA	17.98	19.35	16.88	18.34	17.89	19.98	26.14	26.86	25.76	22.77	21.81	21.16
	VPS	27.20	26.49	25.09	25.35	26.06	27.49	30.11	33.96	33.87	33.15	29.69	29.81
	CLD	71.66	59.02	55.76	51.92	66.87	78.67	59.55	62.50	65.97	59.16	39.58	48.80
21 N	SPD	6.39	5.24	6.77	7.42	7.77	4.07	5.31	4.28	5.29	5.00	4.89	4.50
116 W	AIR	20.10	21.39	19.35	20.47	19.58	21.99	23.99	25.50	24.94	23.91	21.97	21.10
	SEA	21.05	21.79	20.43	21.98	21.50	23.35	24.58	25.50	25.47	24.89	23.40	23.10
	VPA	18.81	20.17	16.51	18.68	16.87	20.68	25.03	27.35	25.53	22.69	20.87	19.24
	VPS	25.02	26.25	24.12	26.59	25.69	28.98	31.23	32.73	32.65	31.54	28.97	28.36
	CLD	45.83	51.13	51.00	56.25	75.00	69.79	71.59	60.41	76.78	71.42	65.00	40.62
21 N	SPD	4.83	4.80	5.66	6.05	4.74	5.87	4.59	5.51	5.40	5.96	5.14	6.17
117 W	AIR	18.83	19.99	18.74	19.81	19.54	20.78	23.10	25.61	25.21	24.24	23.01	20.69
	SEA	20.49	20.73	19.74	20.98	20.81	21.69	23.28	25.55	25.46	25.15	23.51	22.85
	VPA	15.99	17.36	16.47	17.17	16.34	20.28	23.66	26.40	25.23	23.36	22.34	18.41
	VPS	24.23	24.53	23.18	24.91	24.82	25.97	28.81	32.84	32.66	32.14	29.11	27.97
	CLD	65.27	60.41	66.25	62.50	76.38	73.68	86.45	72.79	65.97	52.08	45.45	80.68
21 N	SPD	6.08	5.09	5.76	7.20	5.79	5.11	5.43	6.48	5.69	4.76	5.62	6.27
118 W	AIR	19.78	20.00	18.89	19.05	20.01	20.38	22.70	24.32	25.04	23.67	23.16	21.04
	SEA	21.08	21.54	21.09	21.48	21.16	22.07	23.73	24.08	25.96	24.68	23.87	22.73
	VPA	17.08	18.23	15.88	17.22	18.56	19.33	23.19	24.81	25.21	22.16	22.01	20.37
	VPS	25.05	25.79	25.07	25.88	25.29	26.67	29.45	30.25	33.77	31.25	29.75	27.88
	CLD	67.18	80.00	71.25	59.16	71.87	83.59	89.58	81.66	71.87	54.16	70.53	69.53
21 N	SPD	7.05	5.71	5.29	7.59	5.32	5.57	5.98	4.76	6.26	5.01	5.55	6.51
119 W	AIR	18.83	20.38	19.31	20.04	19.91	21.56	23.81	24.01	24.08	22.91	22.24	21.02
	SEA	20.51	20.95	19.78	21.24	21.09	22.76	24.50	24.58	25.20	24.35	23.59	21.69
	VPA	15.82	17.82	16.90	17.09	17.60	20.49	24.43	24.71	24.95	21.95	21.00	18.02
	VPS	24.18	24.91	23.17	25.33	25.21	27.86	30.90	30.95	32.27	30.57	29.32	26.00
	CLD	65.00	57.23	56.25	81.25	83.82	80.55	71.05	76.56	70.83	43.98	60.93	68.12
21 N	SPD	5.76	5.84	5.35	6.20	5.86	5.52	6.30	5.53	6.33	5.90	6.28	6.72
120 W	AIR	19.08	19.11	18.98	19.19	19.34	20.92	23.32	23.66	23.31	22.54	21.34	20.02
	SEA	20.81	20.86	20.96	20.87	20.73	21.40	23.59	24.54	25.21	24.16	22.95	21.50
	VPA	16.31	17.35	16.02	17.57	17.59	18.76	23.18	24.37	22.41	21.42	18.32	16.88
	VPS	24.61	24.77	24.88	24.94	24.53	25.54	29.22	30.91	32.12	30.24	28.06	25.72
	CLD	70.00	74.51	65.62	66.07	69.56	80.55	83.03	75.00	67.18	64.88	69.56	77.94

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
22 N	SPD	4.79	4.52	5.39	6.32	6.10	6.20	4.14	4.36	5.57	4.90	4.77	4.92
111 W	AIR	20.96	20.33	20.49	20.08	20.57	21.18	25.34	26.43	27.39	26.01	24.71	22.59
	SEA	22.53	21.71	21.31	20.36	21.07	21.58	25.28	26.82	28.05	26.95	25.81	24.23
	VPA	18.53	17.85	18.48	18.68	19.60	21.10	26.49	28.14	30.06	26.20	23.31	19.95
	VPS	27.44	26.09	25.46	24.03	25.14	25.93	32.49	35.41	38.07	35.72	33.39	30.35
	CLD	42.89	37.70	35.36	37.37	42.09	51.07	42.45	49.13	39.46	39.39	34.73	46.76
22 N	SPD	3.91	4.99	5.89	6.72	6.54	5.66	4.09	5.45	5.00	4.91	4.36	4.94
112 W	AIR	20.77	20.41	19.67	19.87	19.78	20.67	24.14	25.82	26.42	25.40	23.91	22.05
	SEA	22.43	21.74	20.82	20.99	20.93	21.21	24.52	26.31	26.88	26.44	25.30	23.49
	VPA	17.68	17.50	17.06	17.87	18.71	19.75	25.25	27.43	28.14	24.83	22.28	20.52
	VPS	27.19	26.13	24.69	25.00	24.88	25.32	31.02	34.46	35.61	34.64	32.35	29.03
	CLD	44.57	42.25	46.73	44.56	53.38	60.83	41.57	48.80	46.33	36.59	38.47	54.84
22 N	SPD	4.65	5.64	6.00	6.99	6.19	5.16	4.48	4.28	6.13	4.83	5.06	5.21
113 W	AIR	20.42	20.30	19.29	19.55	19.78	20.36	23.48	25.39	26.10	24.48	22.64	21.10
	SEA	21.59	21.35	20.99	20.80	20.86	21.28	23.99	25.94	26.47	25.28	24.35	22.96
	VPA	17.45	17.74	16.50	17.59	18.73	19.58	24.44	26.33	27.41	24.18	20.92	19.50
	VPS	25.91	25.51	24.98	24.66	24.75	25.40	30.05	33.63	34.74	32.37	30.58	28.24
	CLD	48.47	50.31	52.54	57.87	51.78	66.09	47.63	55.35	57.37	42.91	37.70	50.78
22 N	SPD	4.84	5.50	5.85	5.98	6.70	5.73	4.16	4.40	6.86	4.72	4.50	5.08
114 W	AIR	19.09	19.26	19.03	19.70	19.05	20.69	22.67	25.15	25.06	23.43	22.92	20.74
	SEA	21.31	20.81	20.77	21.28	20.73	21.29	23.15	25.83	25.46	24.52	24.10	22.37
	VPA	16.92	16.88	16.57	17.89	17.42	19.65	23.53	26.00	26.74	22.63	21.24	18.88
	VPS	25.51	24.70	24.59	25.39	24.57	25.46	28.48	33.36	32.75	30.89	30.16	27.17
	CLD	55.17	45.13	50.32	58.42	66.74	76.42	60.08	62.09	62.99	54.48	32.75	54.78
22 N	SPD	5.06	6.33	6.26	6.28	6.38	5.99	5.64	6.31	6.34	4.50	4.21	5.22
115 W	AIR	19.00	18.75	18.35	19.06	19.20	20.09	22.70	23.89	24.23	23.68	22.02	20.21
	SEA	20.95	19.78	19.97	20.92	20.80	20.67	22.87	24.78	25.36	24.43	23.89	22.42
	VPA	16.66	16.29	15.81	16.07	17.49	18.19	22.79	24.39	25.07	23.07	20.93	17.82
	VPS	24.91	23.23	23.42	24.83	24.74	24.49	28.02	31.46	32.58	30.72	29.80	27.26
	CLD	54.58	51.38	49.69	70.07	62.85	85.88	67.00	62.50	61.00	45.53	44.53	58.12
22 N	SPD	6.30	6.13	5.25	8.05	6.51	5.56	4.60	7.48	7.61	4.93	5.72	4.98
116 W	AIR	19.21	18.68	18.22	18.80	19.51	20.59	22.70	24.88	23.93	22.78	21.36	19.70
	SEA	20.40	20.12	19.73	20.74	21.01	21.45	23.48	25.43	25.05	23.85	22.84	22.18
	VPA	16.81	16.98	16.17	16.72	18.02	19.88	22.74	26.27	24.67	22.24	19.42	17.27
	VPS	24.07	23.75	23.13	24.58	25.02	25.74	29.12	32.57	31.88	29.69	27.93	26.88
	CLD	55.62	54.50	60.50	68.75	70.25	80.28	72.61	61.66	71.05	47.79	52.17	64.77
22 N	SPD	6.12	5.25	6.08	6.61	6.34	4.11	5.01	7.57	5.14	4.36	5.27	5.11
117 W	AIR	18.61	18.25	18.01	18.92	18.85	20.82	22.45	24.29	24.69	22.22	20.57	20.62
	SEA	20.12	19.69	19.58	19.65	20.80	21.03	23.01	25.35	24.75	23.50	22.48	22.65
	VPA	16.70	16.60	15.98	16.29	16.76	19.85	23.82	24.52	25.31	19.92	19.94	19.11
	VPS	23.62	23.09	22.96	23.02	24.62	25.03	28.26	32.43	31.33	28.99	27.29	27.63
	CLD	57.89	54.89	72.72	69.07	73.33	88.75	71.09	64.28	72.65	61.76	62.50	58.08
22 N	SPD	5.58	6.34	5.34	6.80	5.62	4.95	5.81	4.33	7.00	5.72	5.99	5.68
118 W	AIR	18.98	18.61	17.33	17.81	19.13	20.56	21.66	24.88	23.85	23.32	20.44	19.51
	SEA	20.52	19.63	19.33	19.32	20.50	21.41	22.29	25.20	24.24	23.66	22.65	21.81
	VPA	16.13	16.29	15.34	15.65	16.80	18.87	21.71	25.12	24.85	21.19	18.28	17.74
	VPS	24.23	23.00	22.52	22.57	24.28	25.68	26.96	32.26	30.37	29.35	27.56	26.29
	CLD	63.39	61.66	75.00	77.08	91.34	75.00	70.00	77.67	73.07	65.62	70.45	63.09
22 N	SPD	5.46	6.20	6.28	6.03	6.83	4.44	4.85	5.14	6.92	5.79	5.76	5.88
119 W	AIR	19.58	19.50	18.02	18.79	18.82	20.59	22.13	24.46	23.27	22.26	22.04	20.50
	SEA	20.49	20.65	19.66	20.24	20.82	20.40	22.31	24.80	23.93	23.08	22.57	21.47
	VPA	17.46	18.70	15.37	15.99	16.59	19.04	21.90	25.78	23.49	19.66	20.85	17.24
	VPS	24.17	24.54	23.02	23.83	24.73	24.08	27.00	31.43	29.99	28.34	27.40	25.81
	CLD	50.96	63.28	80.00	71.42	55.35	86.60	90.62	56.94	76.38	69.53	75.52	65.17
22 N	SPD	5.44	4.87	6.13	6.40	5.66	4.86	4.89	5.66	5.11	5.61	5.40	5.40
120 W	AIR	19.34	20.64	18.57	18.36	19.74	20.32	22.18	23.19	24.05	21.93	20.69	21.02
	SEA	20.64	20.78	19.61	19.63	20.44	21.92	22.41	23.74	24.85	22.90	22.41	22.33
	VPA	17.05	19.96	16.24	15.24	17.91	19.00	21.57	23.61	24.27	19.47	18.33	19.54
	VPS	24.44	24.72	22.89	22.94	24.08	26.41	27.23	29.41	31.61	28.13	27.19	27.16
	CLD	65.17	56.61	71.59	75.00	88.36	68.05	82.29	78.12	76.78	66.66	73.61	76.56

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
23 N	SPD	4.88	5.16	5.88	6.23	6.60	5.93	4.39	4.78	5.13	4.94	4.95	5.10
111 W	AIR	20.45	19.64	19.32	18.97	19.20	20.19	24.46	26.61	27.19	26.03	24.08	21.96
	SEA	22.00	20.76	20.05	19.44	19.51	20.22	24.29	26.92	27.82	27.04	25.61	23.78
	VPA	17.95	17.20	17.35	17.74	18.14	19.89	25.69	28.45	29.28	26.30	22.25	19.38
	VPS	26.56	24.62	23.59	22.74	22.89	23.93	30.68	35.74	37.59	35.93	33.00	29.61
	CLD	42.58	33.85	37.29	39.31	39.36	42.76	39.60	41.71	35.90	33.35	33.90	44.85
23 N	SPD	4.89	5.10	5.72	6.60	6.86	6.23	4.29	4.81	5.50	5.07	4.89	5.02
112 W	AIR	20.14	19.41	19.12	18.46	19.09	20.12	23.96	26.09	26.14	24.67	23.41	21.58
	SEA	22.01	20.55	20.04	19.42	19.29	20.18	23.86	26.21	26.79	26.06	24.70	23.34
	VPA	17.54	17.03	17.09	17.02	18.04	19.37	25.12	27.56	27.99	24.69	21.83	18.98
	VPS	26.56	24.31	23.56	22.67	22.49	23.80	29.78	34.20	35.44	33.91	31.30	28.80
	CLD	51.05	37.35	41.22	43.98	46.99	57.34	42.83	43.09	45.40	36.81	32.63	41.58
23 N	SPD	5.18	4.28	5.67	5.94	6.21	6.05	4.39	5.03	5.95	4.99	4.59	4.44
113 W	AIR	19.72	19.90	18.38	18.78	18.93	19.99	23.24	24.85	25.02	24.51	22.94	20.89
	SEA	21.08	21.05	20.08	19.85	19.51	20.23	23.21	25.17	25.53	25.50	24.39	22.47
	VPA	17.27	17.17	16.49	16.58	17.49	18.97	23.95	26.13	25.75	24.32	21.29	19.03
	VPS	25.08	25.02	23.60	23.23	22.78	23.81	28.64	32.18	32.87	32.74	30.66	27.33
	CLD	51.31	61.39	50.35	52.22	50.76	60.76	46.92	59.95	45.59	42.00	46.77	59.68
23 N	SPD	4.31	4.36	5.89	7.08	6.19	5.72	4.61	5.03	5.21	5.48	4.98	5.13
114 W	AIR	19.64	19.02	18.41	18.40	18.86	19.40	22.61	24.67	24.75	23.70	21.92	20.36
	SEA	20.66	20.25	19.86	19.44	19.38	19.83	23.10	24.97	25.44	24.55	23.54	21.68
	VPA	16.63	16.19	15.86	16.66	17.09	18.18	22.81	25.39	26.20	22.36	20.46	18.36
	VPS	24.47	23.86	23.26	22.66	22.60	23.22	28.42	31.76	32.70	31.03	29.12	26.03
	CLD	48.71	49.26	55.70	56.13	71.30	70.70	51.62	64.82	48.65	42.54	33.33	57.63
23 N	SPD	5.04	5.43	5.84	6.22	6.91	4.90	4.62	4.85	6.06	5.43	5.55	5.42
115 W	AIR	18.97	18.65	18.09	18.32	18.80	19.65	21.99	24.04	24.01	23.63	21.20	19.62
	SEA	19.94	19.91	19.58	19.66	19.83	20.35	22.17	25.04	24.77	24.08	23.09	21.06
	VPA	16.18	16.79	15.86	16.07	17.22	18.29	22.35	25.10	24.55	22.70	19.58	17.12
	VPS	23.37	23.42	22.86	22.97	23.23	23.96	26.86	31.90	31.41	30.09	28.40	25.07
	CLD	48.92	48.78	57.55	64.88	66.66	65.72	55.78	56.11	57.37	55.62	45.58	61.98
23 N	SPD	5.47	5.66	6.15	6.31	6.29	5.20	4.73	4.56	5.47	5.02	5.26	5.77
116 W	AIR	17.82	18.13	18.64	18.65	18.61	19.18	21.51	23.94	23.78	22.55	21.07	19.32
	SEA	19.80	18.93	19.39	19.81	19.88	20.12	22.23	24.32	24.19	23.58	22.51	21.23
	VPA	15.51	15.83	15.25	15.60	16.80	17.44	21.47	24.03	23.75	21.72	19.16	17.65
	VPS	23.18	21.93	22.59	23.20	23.29	23.69	26.93	30.50	30.38	29.23	27.34	25.34
	CLD	59.21	58.33	63.14	70.06	77.25	84.37	69.39	63.02	53.53	62.50	59.01	57.95
23 N	SPD	6.27	6.05	5.44	6.20	7.09	5.78	4.93	6.51	6.47	5.13	6.57	5.27
117 W	AIR	18.91	18.10	17.97	18.82	17.94	18.93	21.09	23.11	22.78	22.03	20.97	19.60
	SEA	19.93	18.78	18.83	19.57	19.41	20.20	21.91	24.59	24.01	23.21	22.64	21.04
	VPA	16.56	16.02	16.10	15.69	15.77	17.40	21.07	23.23	22.62	20.71	19.60	17.51
	VPS	23.34	21.80	21.83	22.87	22.60	23.75	26.35	30.98	30.03	28.51	27.61	25.08
	CLD	63.06	46.55	57.10	72.85	65.90	86.58	74.32	77.71	64.77	60.83	48.14	66.57
23 N	SPD	5.68	6.17	5.17	6.65	6.37	6.46	5.25	5.43	6.29	5.66	5.03	4.83
118 W	AIR	18.29	17.78	17.82	18.42	17.78	19.47	20.98	23.50	23.22	22.36	20.41	18.98
	SEA	19.55	18.87	18.91	19.18	19.24	20.32	21.97	23.89	23.99	23.66	21.40	20.46
	VPA	15.62	15.78	14.45	15.62	15.60	17.79	20.76	22.87	23.09	19.87	17.99	17.12
	VPS	22.84	21.90	21.99	22.33	22.44	23.93	26.54	29.73	29.93	29.36	25.58	24.16
	CLD	53.36	58.00	67.61	74.58	75.00	86.50	72.39	79.86	66.34	63.58	53.80	68.75
23 N	SPD	6.01	6.08	5.35	6.50	5.86	5.71	5.33	5.31	6.66	5.12	6.43	6.69
119 W	AIR	17.88	17.35	17.23	17.73	18.15	19.54	21.05	23.13	22.35	21.29	21.31	19.76
	SEA	19.66	18.65	18.67	19.24	19.42	20.76	22.05	23.33	23.31	22.33	22.09	21.16
	VPA	14.99	15.49	15.20	15.17	15.95	17.71	21.26	23.18	20.80	19.49	18.87	17.60
	VPS	22.99	21.54	21.67	22.37	22.62	24.62	26.62	28.72	28.70	27.12	26.63	25.24
	CLD	57.89	64.22	61.25	75.00	75.00	80.41	84.65	71.66	85.41	45.45	61.60	55.35
23 N	SPD	6.63	5.33	4.94	7.07	4.87	4.79	6.43	4.63	6.97	5.34	5.43	5.83
120 W	AIR	18.18	17.18	18.39	18.33	18.93	19.86	22.04	23.50	22.20	22.35	20.26	19.50
	SEA	19.55	18.27	19.23	19.34	20.23	20.83	22.24	23.93	23.57	22.85	22.07	21.55
	VPA	15.50	14.50	14.89	15.18	16.53	18.18	23.39	24.85	21.15	20.95	17.83	16.44
	VPS	22.80	21.08	22.36	22.49	23.89	24.65	26.98	29.77	29.14	27.96	26.70	25.89
	CLD	62.50	66.44	69.23	72.65	76.66	78.84	82.29	74.26	78.75	53.84	73.36	69.64

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
24 N	SPD	4.58	5.17	5.90	6.30	6.61	5.95	4.58	5.07	5.07	4.97	4.95	4.67
111 W	AIR	19.99	19.19	18.72	18.46	18.37	19.41	23.85	26.08	26.99	25.52	23.50	21.54
	SEA	21.64	20.28	19.34	18.79	18.74	19.05	23.60	26.52	27.54	26.88	25.26	23.43
	VPA	17.53	16.80	16.81	17.27	17.63	19.16	24.85	27.76	28.95	25.66	21.82	18.77
	VPS	25.99	23.91	22.58	21.82	21.80	22.22	29.53	34.97	37.00	35.62	32.33	28.98
	CLD	40.55	32.78	34.91	37.31	39.96	37.81	37.59	41.11	33.92	30.50	32.79	41.62
24 N	SPD	4.60	4.90	5.76	6.20	6.57	5.86	4.37	4.86	5.18	5.06	4.77	4.61
112 W	AIR	19.65	18.82	18.43	18.10	18.27	19.02	23.03	25.35	26.20	24.85	23.00	21.09
	SEA	21.06	19.60	18.77	18.24	18.04	18.55	22.67	25.62	26.71	25.95	24.39	22.85
	VPA	17.03	16.44	16.57	16.79	17.21	18.53	23.94	26.78	27.78	24.88	21.05	18.12
	VPS	25.09	22.92	21.78	21.07	20.81	21.51	27.82	33.16	35.27	33.76	30.72	28.00
	CLD	44.06	38.00	37.94	42.63	43.78	47.51	39.86	41.98	33.69	32.85	36.43	44.16
24 N	SPD	4.81	5.55	6.15	6.91	6.59	6.26	5.09	4.96	5.55	5.50	4.61	5.00
113 W	AIR	19.43	19.03	18.05	18.03	18.31	19.20	22.30	24.48	25.17	24.17	22.40	20.76
	SEA	20.78	19.94	18.56	18.39	18.29	19.08	22.32	24.66	25.66	25.28	23.56	22.19
	VPA	16.55	16.43	15.98	16.20	17.11	18.39	23.09	25.58	26.69	23.93	20.46	17.72
	VPS	24.65	23.42	21.50	21.26	21.11	22.17	27.14	31.27	33.17	32.40	29.23	26.90
	CLD	47.26	43.88	44.34	46.10	55.31	59.41	44.80	47.50	40.03	38.04	39.77	42.03
24 N	SPD	4.88	6.17	6.01	6.10	5.98	6.36	4.83	4.82	5.70	5.08	5.61	6.42
114 W	AIR	17.96	18.46	18.29	18.07	18.28	19.10	21.19	24.47	24.17	22.92	21.71	19.64
	SEA	19.39	19.82	18.64	18.35	18.73	19.42	21.46	24.20	24.62	23.49	23.40	20.59
	VPA	15.81	15.30	16.28	16.26	17.06	18.75	21.42	25.50	25.01	22.37	20.67	17.41
	VPS	22.60	23.17	21.59	21.22	21.65	22.66	25.81	30.38	31.18	29.09	28.87	24.42
	CLD	44.75	52.67	64.06	65.51	67.26	78.88	53.43	53.48	47.50	48.50	52.57	41.44
24 N	SPD	5.37	5.47	6.10	7.29	6.34	6.02	6.24	4.81	5.92	4.99	5.25	5.41
115 W	AIR	18.07	18.31	17.54	18.13	18.52	19.68	21.07	23.39	23.88	22.46	21.48	19.99
	SEA	18.62	18.93	18.33	18.31	18.73	19.73	21.42	23.95	24.05	23.53	22.45	20.36
	VPA	15.44	15.69	15.46	15.95	16.30	18.50	20.56	23.88	24.63	21.47	19.85	17.24
	VPS	21.57	21.97	21.17	21.18	21.69	23.17	25.65	29.81	30.03	29.16	27.34	24.07
	CLD	52.77	56.94	62.50	65.47	67.30	66.30	57.18	56.39	42.50	40.50	48.68	58.33
24 N	SPD	5.51	5.10	6.82	6.83	7.28	5.58	4.63	5.02	6.04	5.75	5.02	5.89
116 W	AIR	17.82	17.67	17.50	18.00	18.53	19.48	21.61	23.73	22.92	21.84	20.48	19.21
	SEA	19.11	19.11	18.77	18.55	19.19	19.70	21.87	23.83	23.38	22.93	21.72	20.21
	VPA	15.91	15.08	15.04	15.84	16.76	18.10	20.80	24.18	23.20	19.83	18.51	16.77
	VPS	22.17	22.22	21.74	21.47	22.28	23.03	26.38	29.69	28.86	28.09	26.11	23.79
	CLD	50.00	56.78	54.51	66.75	72.15	76.45	64.68	65.48	55.63	50.23	48.50	60.52
24 N	SPD	5.55	6.04	6.33	6.89	6.08	5.93	4.72	4.85	5.52	5.12	5.30	4.96
117 W	AIR	17.14	17.43	17.96	17.57	18.25	19.36	21.34	22.57	22.69	22.17	20.42	18.78
	SEA	18.57	18.32	18.93	18.29	19.04	19.65	21.43	23.35	23.70	22.80	21.65	19.80
	VPA	15.02	15.51	14.30	15.15	16.17	16.93	20.83	22.97	22.17	20.80	18.40	16.34
	VPS	21.46	21.13	21.92	21.11	22.09	22.93	25.72	28.83	29.41	27.87	25.98	23.22
	CLD	57.23	66.07	61.20	66.25	65.94	74.79	70.31	61.63	63.20	51.20	61.07	57.40
24 N	SPD	5.21	5.92	5.90	6.89	6.25	4.60	4.83	4.86	5.81	5.33	5.25	5.92
118 W	AIR	17.30	17.45	17.60	17.51	18.30	19.63	20.80	23.00	22.65	21.68	20.19	17.99
	SEA	18.77	18.58	18.21	18.67	19.33	19.78	21.54	23.65	23.12	22.75	21.76	20.00
	VPA	14.66	15.46	14.67	14.63	16.04	17.42	20.08	23.43	22.44	20.22	17.52	14.98
	VPS	21.71	21.49	20.98	21.57	22.50	23.14	25.81	29.29	28.42	27.75	26.15	23.47
	CLD	76.08	68.12	68.75	74.24	77.16	84.88	71.22	73.21	67.61	68.50	60.05	63.23
24 N	SPD	5.11	6.76	5.93	6.29	6.78	5.80	5.22	5.86	5.93	5.49	5.74	4.83
119 W	AIR	16.74	17.34	16.81	18.24	17.92	19.26	20.95	23.06	22.11	21.05	19.94	18.21
	SEA	18.37	18.36	18.43	18.83	19.26	19.55	21.54	23.67	23.31	22.54	21.29	19.79
	VPA	15.04	15.50	14.21	15.75	15.85	17.23	20.29	23.40	21.30	19.05	17.35	15.51
	VPS	21.15	21.20	21.28	21.83	22.41	22.91	25.80	29.44	28.75	27.37	25.36	23.16
	CLD	67.85	65.35	64.40	77.74	72.30	86.11	83.05	78.92	69.58	66.28	65.32	68.42
24 N	SPD	5.41	5.79	5.92	6.25	6.00	5.12	5.66	6.06	7.35	5.92	5.00	5.38
120 W	AIR	17.96	17.44	17.15	17.73	18.04	19.46	19.87	21.88	22.20	21.38	19.73	18.38
	SEA	18.84	18.40	18.29	18.87	18.91	20.51	20.65	22.54	22.52	22.30	21.42	20.02
	VPA	15.65	15.38	14.42	14.49	15.15	17.98	18.97	20.83	20.97	19.06	16.94	15.91
	VPS	21.86	21.23	21.08	21.84	21.90	24.30	24.42	27.43	27.37	27.06	25.57	23.49
	CLD	59.67	57.97	69.23	74.26	75.32	89.50	85.08	72.82	72.50	65.32	65.54	69.93

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
25 N 113 W	SPD	4.75	5.49	6.19	6.51	6.61	6.02	4.96	5.03	5.44	5.19	4.95	4.91
	AIR	18.86	18.32	17.62	17.61	17.68	18.68	21.73	23.97	24.84	23.62	21.74	20.10
	SEA	19.99	19.03	18.07	17.66	17.52	18.25	21.32	24.19	25.26	24.77	23.03	21.69
	VPA	16.16	15.83	15.60	16.23	16.65	18.08	22.34	25.11	26.02	23.36	19.72	17.34
	VPS	23.49	22.12	20.83	20.30	20.10	21.06	25.56	30.46	32.43	31.47	28.31	26.10
	CLD	43.75	39.20	41.48	44.97	48.26	50.12	42.87	41.90	32.41	31.72	38.19	42.32
25 N 114 W	SPD	5.06	5.73	7.28	6.61	7.21	6.80	5.35	5.31	5.71	5.62	5.63	5.39
	AIR	18.51	17.72	17.07	17.36	17.90	18.61	21.07	23.22	23.76	22.56	21.55	19.42
	SEA	19.57	18.47	17.87	17.62	17.62	18.32	21.09	23.12	24.09	23.71	22.52	20.85
	VPA	16.55	15.06	15.13	15.75	16.63	17.75	21.33	24.15	24.72	21.78	19.81	16.60
	VPS	22.91	21.35	20.57	20.23	20.22	21.12	25.17	28.44	30.20	29.48	27.46	24.80
	CLD	44.83	45.44	42.58	50.78	53.90	63.17	52.03	50.69	39.47	36.10	38.51	41.11
25 N 115 W	SPD	6.69	5.27	6.15	6.38	6.47	6.49	5.35	5.00	6.14	5.40	4.79	5.42
	AIR	17.83	18.25	17.17	17.60	17.86	18.09	20.88	23.16	23.12	21.88	20.63	19.36
	SEA	18.95	18.26	17.77	18.16	18.04	18.36	20.84	23.17	22.91	22.61	21.87	20.35
	VPA	16.42	15.50	15.01	15.93	16.59	17.26	20.77	23.69	23.47	20.23	19.29	17.32
	VPS	21.99	21.06	20.46	20.91	20.74	21.19	24.78	28.54	28.08	27.58	26.40	24.09
	CLD	48.75	49.50	51.72	66.07	59.09	71.35	63.97	59.31	49.09	56.12	42.50	44.79
25 N 116 W	SPD	5.70	5.35	6.49	5.25	6.85	5.98	4.71	4.93	5.71	5.61	4.91	6.52
	AIR	17.41	17.13	17.82	17.44	17.42	18.47	20.81	23.11	23.06	21.28	20.14	18.56
	SEA	18.00	18.29	18.08	17.46	18.04	18.38	20.85	23.22	23.52	22.22	20.97	20.00
	VPA	14.92	14.95	14.76	15.18	15.83	17.30	20.56	23.11	23.13	19.68	18.43	17.09
	VPS	20.69	21.06	20.83	20.03	20.79	21.19	24.71	28.61	29.11	26.89	24.88	23.45
	CLD	50.00	38.12	48.80	66.44	66.40	79.31	63.17	67.56	56.64	58.12	41.34	47.22
25 N 117 W	SPD	5.19	6.02	6.28	6.05	6.59	6.04	5.53	4.77	5.49	5.92	5.00	5.50
	AIR	16.84	17.34	17.27	16.88	18.02	18.78	21.00	22.35	22.34	21.29	20.27	18.40
	SEA	17.90	17.93	18.00	17.87	18.32	18.77	20.88	23.02	22.63	22.00	21.10	19.48
	VPA	15.02	14.75	16.04	14.67	16.06	17.49	20.13	22.35	22.28	19.45	18.41	16.61
	VPS	20.57	20.61	20.75	20.53	21.11	21.78	24.76	28.21	27.56	26.52	25.08	22.74
	CLD	42.26	64.67	55.00	58.45	76.27	81.94	69.79	70.75	54.86	53.71	55.46	43.75
25 N 118 W	SPD	5.44	5.29	6.74	7.29	6.93	5.50	4.72	5.39	5.38	5.14	5.95	5.45
	AIR	17.12	17.58	17.29	17.19	18.10	18.84	20.50	22.28	21.77	21.10	19.70	17.96
	SEA	18.09	18.02	17.73	17.75	18.40	19.34	20.79	22.88	22.36	22.20	21.03	19.38
	VPA	14.89	15.29	14.99	15.04	15.82	17.58	19.43	21.98	20.85	19.16	18.06	15.31
	VPS	20.84	20.71	20.35	20.38	21.21	22.50	24.66	28.00	27.11	26.87	25.00	22.58
	CLD	54.16	52.60	54.62	64.93	72.36	82.90	71.87	74.07	69.47	55.46	62.50	42.85
25 N 119 W	SPD	6.14	5.43	5.56	7.43	6.46	5.70	5.17	5.06	6.18	5.47	5.71	5.39
	AIR	17.02	17.09	16.65	17.20	17.57	18.80	19.57	21.76	21.26	21.23	19.42	17.78
	SEA	18.53	17.55	17.55	17.94	18.49	19.10	20.80	22.42	22.34	22.21	21.16	19.28
	VPA	14.94	14.72	14.52	14.46	15.35	16.33	18.85	21.53	20.35	19.50	17.42	15.59
	VPS	21.41	20.13	20.10	20.60	21.33	22.16	24.65	27.23	27.07	26.82	25.19	22.39
	CLD	58.33	72.22	70.06	65.38	68.51	83.00	84.55	79.16	70.28	50.23	53.12	67.70
25 N 120 W	SPD	6.03	5.77	5.09	6.14	6.42	5.58	4.84	4.43	5.25	5.50	5.62	5.94
	AIR	16.85	17.10	17.19	17.26	18.01	18.88	19.80	21.94	21.39	20.78	19.70	17.99
	SEA	18.71	18.10	17.61	18.43	18.86	19.15	20.76	22.57	21.84	22.07	20.99	19.61
	VPA	14.90	14.76	14.56	14.41	15.55	16.62	19.07	21.06	19.78	19.10	17.60	14.68
	VPS	21.62	20.82	20.19	21.26	21.82	22.23	24.56	27.50	26.28	26.64	24.92	22.93
	CLD	65.47	61.29	67.81	81.11	81.83	83.12	84.23	67.61	73.57	57.81	67.85	69.39
25 N 121 W	SPD	5.90	5.49	5.88	6.14	5.98	5.82	5.21	6.34	6.19	5.86	6.03	5.66
	AIR	17.15	16.55	16.72	17.13	17.60	19.01	19.41	21.14	21.33	21.33	19.53	18.58
	SEA	18.60	17.70	18.29	18.13	18.99	19.51	20.37	21.52	22.20	22.22	21.09	19.67
	VPA	14.13	14.53	13.81	14.96	15.16	17.31	18.17	20.23	20.69	19.19	16.39	15.80
	VPS	21.48	20.34	21.13	20.85	22.03	22.82	24.04	25.80	26.86	26.88	25.08	22.98
	CLD	70.50	75.00	69.16	79.16	75.00	85.71	83.92	81.61	77.85	59.21	69.71	69.31
25 N 122 W	SPD	4.61	6.29	5.81	5.96	5.43	5.38	5.82	5.20	7.05	5.24	6.13	6.02
	AIR	17.88	17.50	17.18	17.73	18.16	18.64	19.90	20.96	21.19	20.79	19.64	17.82
	SEA	18.79	18.24	18.31	18.52	18.85	19.48	20.33	22.06	22.35	21.59	21.46	19.54
	VPA	15.19	15.74	14.11	15.08	15.14	17.12	18.91	20.60	19.86	17.93	16.73	15.64
	VPS	21.75	21.02	21.10	21.40	21.85	22.82	23.90	26.61	27.11	25.84	25.62	22.77
	CLD	62.98	69.75	70.56	74.14	78.04	81.77	88.28	83.92	63.88	72.22	75.92	74.34

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
26 N	SPD	5.41	5.30	6.21	6.73	6.65	6.38	4.80	5.29	5.59	5.74	5.22	5.21
113 W	AIR	18.32	17.81	17.21	16.98	17.16	18.05	21.07	23.00	23.63	22.78	21.36	19.48
	SEA	19.59	18.43	17.62	17.06	17.14	17.60	20.70	23.20	24.47	24.15	22.62	21.15
	VPA	15.92	15.35	15.39	15.72	16.13	17.57	21.79	23.97	24.63	22.09	19.13	16.64
	VPS	22.92	21.31	20.24	19.53	19.64	20.22	24.62	28.66	30.94	30.35	27.61	25.27
	CLD	40.52	37.07	38.19	41.88	39.34	41.62	38.17	36.33	32.87	30.42	35.38	37.62
26 N	SPD	5.26	5.78	6.56	6.76	6.95	6.63	5.48	5.42	5.74	5.67	5.38	5.44
114 W	AIR	17.76	17.40	16.85	16.89	17.22	17.96	20.45	22.38	23.20	22.22	20.59	18.95
	SEA	18.87	18.12	17.30	16.97	17.12	17.70	20.22	22.43	23.61	23.18	21.69	20.36
	VPA	15.22	14.92	14.91	15.34	16.07	17.30	20.80	23.20	24.09	21.46	18.54	16.16
	VPS	21.91	20.89	19.84	19.41	19.61	20.36	23.86	27.39	29.37	28.61	26.10	24.07
	CLD	41.31	39.76	40.47	42.13	44.33	43.55	40.75	34.54	32.32	29.66	37.23	39.48
26 N	SPD	5.72	6.10	6.87	6.70	7.78	7.12	5.61	5.25	6.32	5.70	5.22	5.40
115 W	AIR	17.77	17.15	16.87	16.65	17.39	18.17	20.10	22.54	22.46	21.71	20.32	18.22
	SEA	18.09	17.56	16.85	17.15	17.53	17.99	20.16	22.23	22.85	22.49	21.11	19.52
	VPA	15.71	14.79	14.83	15.84	16.08	16.72	20.30	22.90	23.42	20.83	18.75	15.90
	VPS	20.87	20.16	19.25	19.63	20.11	20.68	23.75	26.96	27.99	27.42	25.16	22.84
	CLD	48.23	37.00	47.27	57.60	54.38	59.31	50.68	53.21	48.23	39.18	43.53	44.23
26 N	SPD	5.89	6.98	7.33	8.07	6.90	6.39	5.14	4.63	6.36	5.21	5.82	5.86
116 W	AIR	17.12	16.67	16.67	17.01	17.43	18.40	20.47	21.97	21.89	21.15	20.17	18.27
	SEA	17.90	17.58	17.30	17.24	17.66	18.05	20.23	22.39	22.33	21.80	20.82	19.07
	VPA	15.62	14.40	13.90	14.98	15.82	16.96	20.13	22.13	21.96	20.09	18.60	17.81
	VPS	20.57	20.19	19.80	19.72	20.26	20.79	23.83	27.15	27.19	26.23	24.69	22.18
	CLD	52.60	43.75	55.20	56.08	70.83	75.43	64.35	66.56	51.78	44.03	30.68	51.25
26 N	SPD	4.76	6.54	8.65	6.37	5.03	5.38	5.05	5.21	5.55	4.79	5.39	5.86
117 W	AIR	16.31	16.82	17.07	16.59	17.43	18.23	19.95	22.40	21.04	20.94	19.10	17.54
	SEA	17.94	17.42	17.11	17.50	17.98	18.37	19.93	22.24	21.76	21.18	20.13	18.81
	VPA	14.22	14.42	15.27	14.96	15.43	16.81	18.94	22.46	20.66	18.56	16.76	15.44
	VPS	20.67	19.94	19.58	20.06	20.68	21.20	23.38	26.96	26.12	25.21	23.64	21.78
	CLD	51.04	31.25	25.00	66.93	76.78	75.00	73.05	67.81	56.25	58.46	56.00	52.50
26 N	SPD	5.27	6.32	6.28	5.79	5.99	6.22	4.90	5.31	6.18	5.72	4.94	5.66
118 W	AIR	16.42	16.61	16.01	17.04	17.24	18.20	19.87	21.92	21.11	20.40	18.93	17.43
	SEA	17.40	17.33	16.90	17.30	17.81	18.25	19.79	21.79	21.75	21.28	19.72	18.01
	VPA	15.06	13.94	13.45	15.28	14.28	16.19	18.62	21.44	20.61	18.67	17.67	15.69
	VPS	19.92	19.82	19.33	19.83	20.43	21.01	23.17	26.20	26.12	25.35	23.06	20.78
	CLD	62.00	38.69	61.60	69.56	77.82	88.70	89.45	73.02	64.50	56.04	43.75	55.76
26 N	SPD	5.78	6.12	5.52	6.98	6.54	5.73	5.40	4.97	5.54	5.29	5.56	5.54
119 W	AIR	16.26	16.28	17.19	15.98	17.73	18.55	19.48	20.80	21.52	19.94	18.98	18.15
	SEA	17.50	17.51	17.27	17.06	17.71	18.58	19.98	21.45	21.68	21.47	20.13	19.01
	VPA	14.29	14.26	14.41	14.14	15.80	16.46	18.77	20.27	19.81	18.02	16.41	16.15
	VPS	20.06	20.06	19.75	19.50	20.32	21.49	23.44	25.63	26.02	25.71	23.61	22.05
	CLD	50.00	60.71	63.81	52.91	80.90	86.11	81.90	64.64	73.86	52.00	67.96	53.67
26 N	SPD	5.29	6.33	6.57	7.17	6.49	5.03	5.66	5.18	5.96	5.31	5.11	5.62
120 W	AIR	17.05	17.01	16.67	16.83	17.27	18.41	19.20	21.00	20.94	20.36	19.56	17.95
	SEA	17.64	17.53	17.64	17.16	18.09	19.04	19.83	21.72	21.77	21.51	20.59	18.93
	VPA	15.49	13.55	14.85	14.50	15.31	16.43	18.19	20.33	20.01	18.28	17.62	15.49
	VPS	20.22	20.04	20.20	19.63	20.81	22.11	23.20	26.07	26.15	25.75	24.38	21.96
	CLD	58.92	71.87	60.18	67.27	68.99	77.55	87.23	80.44	70.83	64.72	70.31	62.91
26 N	SPD	5.67	4.28	5.55	6.36	6.41	5.70	5.88	5.72	6.42	5.53	5.97	6.70
121 W	AIR	17.50	16.77	16.17	16.70	17.64	18.16	19.24	20.80	20.83	20.41	18.69	17.54
	SEA	18.44	17.71	17.46	17.61	18.45	18.80	20.29	21.24	21.41	21.09	20.52	18.92
	VPA	14.83	14.57	14.24	14.27	15.06	16.28	18.56	20.02	19.13	18.45	16.95	14.80
	VPS	21.26	20.30	20.00	20.18	21.35	21.75	23.86	25.39	25.56	25.05	24.19	22.03
	CLD	61.36	62.50	78.44	65.48	74.72	83.68	74.35	78.38	71.13	57.77	69.64	67.96
26 N	SPD	5.42	5.56	6.21	6.25	6.58	5.13	5.42	5.65	6.28	5.26	4.88	5.93
122 W	AIR	16.81	16.60	16.50	16.54	17.54	18.33	19.38	20.71	20.76	20.68	19.19	18.00
	SEA	18.73	18.26	17.99	17.96	18.31	18.75	20.25	21.02	21.77	21.19	20.87	19.45
	VPA	14.65	14.15	13.87	13.92	14.99	16.51	17.75	20.75	18.85	18.38	17.11	15.44
	VPS	21.68	21.03	20.66	20.62	21.10	21.70	23.83	24.98	26.17	25.23	24.77	22.66
	CLD	72.39	68.75	71.25	65.35	79.72	81.64	86.00	82.44	77.81	69.47	65.27	75.00

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
27 N	SPD	5.45	5.78	6.15	6.43	6.96	6.46	5.53	5.33	5.67	5.53	5.13	5.29
114 W	AIR	17.32	16.83	16.29	16.45	16.74	17.34	19.97	21.90	22.69	21.65	20.17	18.79
	SEA	18.55	17.56	16.70	16.53	16.65	17.01	19.44	21.63	23.26	22.79	21.36	20.02
	VPA	14.57	14.48	14.25	15.24	15.67	16.87	20.14	22.35	23.21	20.61	18.04	15.79
	VPS	21.48	20.16	19.09	18.89	19.03	19.50	22.74	26.10	28.77	27.96	25.59	23.60
	CLD	39.54	39.25	37.56	39.52	37.59	37.21	38.05	31.19	31.33	31.31	33.47	39.14
27 N	SPD	5.48	6.16	6.68	6.87	6.96	6.91	5.89	5.73	6.03	6.02	5.63	5.91
115 W	AIR	17.03	16.60	16.19	16.30	16.79	17.35	19.59	21.34	21.95	21.02	19.73	18.03
	SEA	17.86	17.08	16.31	16.33	16.61	17.15	19.28	21.20	22.21	21.78	20.45	19.10
	VPA	14.67	14.41	14.33	14.86	15.50	16.58	19.59	21.55	22.11	19.98	17.75	15.21
	VPS	20.57	19.57	18.62	18.63	18.99	19.66	22.52	25.36	26.97	26.28	24.21	22.26
	CLD	40.17	39.41	42.63	42.41	46.66	49.95	44.75	37.62	35.70	34.07	36.07	39.03
27 N	SPD	6.21	7.04	6.24	6.12	7.22	7.10	5.70	5.08	6.05	5.90	5.41	6.42
116 W	AIR	16.72	16.37	16.40	16.50	16.76	18.12	19.59	21.44	21.93	20.54	20.06	17.54
	SEA	17.30	16.80	16.48	16.61	17.02	18.08	19.74	21.38	21.90	21.13	20.15	19.01
	VPA	14.92	14.05	14.35	14.74	14.92	16.99	19.31	21.69	22.07	19.93	18.27	15.86
	VPS	19.80	19.19	18.79	18.97	19.49	20.83	23.16	25.58	26.41	25.24	23.72	22.08
	CLD	51.29	35.03	55.32	64.83	72.94	76.96	76.08	57.52	54.55	49.78	42.36	44.23
27 N	SPD	6.32	5.54	6.72	6.84	6.90	6.08	5.39	4.96	5.68	6.15	5.60	6.04
117 W	AIR	16.37	16.24	16.39	16.57	17.12	17.66	19.86	21.52	20.92	20.10	19.04	17.54
	SEA	16.82	16.97	16.31	16.77	17.76	18.16	19.81	21.50	21.59	20.71	19.97	18.07
	VPA	15.00	14.01	13.89	14.52	15.72	16.71	19.41	21.35	20.39	18.85	17.24	15.83
	VPS	19.18	19.41	18.60	19.14	20.37	20.92	23.22	25.74	25.87	24.51	23.40	20.87
	CLD	63.54	53.33	60.41	67.81	75.56	79.08	71.18	74.31	62.69	67.15	44.07	43.42
27 N	SPD	5.39	6.79	7.61	6.58	5.13	5.62	5.23	5.62	6.65	4.36	5.62	6.53
118 W	AIR	16.52	16.40	16.49	16.14	17.03	17.88	19.58	21.02	20.94	19.98	18.92	18.15
	SEA	17.10	17.16	16.86	17.15	17.45	17.54	19.50	21.05	21.24	21.01	19.59	18.67
	VPA	14.92	13.90	14.82	14.76	15.21	16.00	18.58	20.24	20.27	18.11	17.46	16.54
	VPS	19.56	19.61	19.25	19.61	19.97	20.10	22.75	25.02	25.32	24.93	22.86	21.63
	CLD	64.88	59.16	55.83	69.16	79.43	80.48	78.07	76.70	59.30	57.00	55.09	64.84
27 N	SPD	5.28	5.86	5.97	7.14	5.50	5.34	4.89	4.54	5.58	5.02	4.79	5.79
119 W	AIR	16.19	16.68	16.85	16.71	17.05	18.15	19.12	20.33	21.12	19.96	19.04	16.88
	SEA	17.41	17.15	17.13	17.33	17.83	18.13	19.03	20.21	20.82	20.84	19.61	18.14
	VPA	15.33	14.86	14.69	14.40	14.82	16.82	17.82	18.74	19.15	18.29	17.01	14.41
	VPS	19.93	19.57	19.55	19.83	20.53	20.82	22.07	23.74	24.67	24.68	22.91	20.93
	CLD	45.00	43.75	65.00	60.93	79.31	76.29	82.81	76.25	64.33	63.63	60.79	67.70
27 N	SPD	6.00	6.17	5.85	7.00	6.36	4.99	5.34	4.80	5.30	5.41	5.83	4.54
120 W	AIR	16.67	16.38	15.81	16.31	17.15	17.85	18.51	21.04	20.43	19.78	18.98	17.31
	SEA	17.92	17.72	17.30	16.87	17.53	17.44	19.13	20.71	21.11	21.17	19.63	18.66
	VPA	14.67	15.04	13.13	13.75	14.59	15.56	17.78	20.08	18.88	17.29	17.09	14.02
	VPS	20.60	20.32	19.80	19.28	20.09	19.99	22.20	24.52	25.22	25.25	22.88	21.56
	CLD	42.85	67.04	76.97	59.02	84.82	91.14	83.17	72.72	65.23	66.84	62.50	64.58
27 N	SPD	5.86	4.54	6.63	7.17	6.02	4.66	5.10	5.44	5.10	5.01	5.28	6.43
121 W	AIR	16.32	16.74	17.21	16.17	17.90	17.91	18.77	19.99	20.61	19.94	18.93	16.38
	SEA	17.32	17.35	17.40	16.98	17.49	18.58	19.36	20.55	21.07	21.10	19.60	18.29
	VPA	14.70	14.62	14.43	14.46	15.38	15.72	17.93	19.35	19.03	17.61	16.27	14.59
	VPS	19.85	19.82	19.90	19.42	20.03	21.53	22.52	24.22	25.04	25.09	22.84	21.10
	CLD	53.12	56.61	54.41	62.86	72.36	88.97	84.25	66.37	72.82	62.50	52.71	50.00
27 N	SPD	5.08	6.32	6.08	6.71	6.05	6.64	6.40	6.31	5.75	4.92	6.21	5.58
122 W	AIR	16.00	16.01	16.63	16.55	17.56	17.33	19.16	20.20	20.32	19.61	19.28	17.49
	SEA	18.04	17.87	16.97	17.09	18.15	18.46	19.67	20.34	20.90	21.03	19.90	18.83
	VPA	14.03	13.57	14.67	14.05	14.98	15.62	17.85	19.60	19.12	16.45	17.57	14.91
	VPS	20.75	20.51	19.38	19.53	20.91	21.30	23.02	24.00	24.78	24.99	23.29	21.84
	CLD	58.85	75.00	66.66	66.34	71.73	84.44	86.28	67.37	73.43	64.28	67.12	66.07
27 N	SPD	5.46	5.93	6.15	6.77	6.15	6.25	5.99	5.63	5.35	5.36	6.27	6.41
123 W	AIR	16.25	16.59	16.49	16.25	17.03	18.11	18.66	19.91	20.45	20.09	18.42	17.45
	SEA	17.72	17.44	17.48	17.58	17.54	18.94	19.61	20.28	20.86	20.98	19.93	18.42
	VPA	14.41	15.32	14.35	14.17	14.94	16.43	17.25	18.77	18.83	18.05	17.01	15.21
	VPS	20.37	19.98	20.01	20.14	20.10	21.97	22.88	23.83	24.74	24.89	23.34	21.35
	CLD	74.30	62.50	71.34	65.48	80.70	80.59	82.03	77.45	75.00	64.31	69.07	52.65

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
28 N	SPD	5.83	6.34	6.82	6.68	6.74	6.47	5.67	5.31	5.86	5.83	5.77	5.84
115 W	AIR	16.79	16.18	16.08	16.22	16.96	17.38	19.14	20.81	21.40	20.36	18.93	17.74
	SEA	17.45	16.46	16.00	15.94	16.27	16.87	18.72	20.40	21.59	21.16	19.82	18.84
	VPA	14.17	13.92	13.90	14.63	15.24	16.23	18.92	20.65	21.28	19.17	17.08	15.24
	VPS	20.03	18.80	18.26	18.19	18.59	19.31	21.72	24.16	25.98	25.31	23.29	21.90
	CLD	39.94	41.96	49.02	53.16	59.03	64.91	55.64	45.21	44.56	42.83	38.47	43.69
28 N	SPD	5.72	6.16	6.48	6.65	6.64	6.20	5.70	5.36	5.55	5.61	5.70	6.10
116 W	AIR	16.22	15.84	15.96	16.33	16.87	17.48	19.32	20.84	21.16	20.13	18.65	17.08
	SEA	16.92	16.32	15.92	16.15	16.63	17.18	18.95	20.70	21.20	20.74	19.29	17.99
	VPA	14.41	13.96	14.16	14.67	15.29	16.44	18.92	20.58	20.97	18.97	16.83	14.66
	VPS	19.37	18.63	18.16	18.42	18.99	19.65	22.01	24.55	25.31	24.62	22.49	20.75
	CLD	46.40	47.05	52.86	59.19	69.63	81.76	74.33	64.71	56.35	48.58	44.34	45.96
28 N	SPD	5.50	5.39	6.15	6.52	6.47	5.56	5.25	5.31	5.08	5.57	4.47	7.27
117 W	AIR	16.52	15.95	15.94	16.61	17.52	17.44	19.53	21.08	21.39	19.78	18.90	17.08
	SEA	16.76	16.64	16.01	16.53	17.07	17.34	19.42	21.11	21.16	20.11	18.84	17.70
	VPA	14.95	14.09	13.93	14.98	15.23	16.14	19.39	21.27	20.98	18.48	17.62	15.35
	VPS	19.12	18.99	18.23	18.86	19.52	19.87	22.64	25.14	25.19	23.60	21.87	20.28
	CLD	48.52	54.32	64.75	59.61	71.13	88.58	78.43	69.79	66.74	48.69	48.02	50.00
28 N	SPD	4.92	5.73	5.21	7.69	6.43	6.30	4.79	5.26	5.82	5.14	5.86	6.30
118 W	AIR	16.01	16.12	15.42	16.03	16.75	17.62	19.46	20.05	20.25	19.37	19.24	16.94
	SEA	16.28	16.52	16.64	16.70	17.22	17.96	19.10	20.80	20.66	20.20	19.65	17.68
	VPA	13.81	14.34	13.22	14.31	14.55	16.55	18.69	19.91	18.87	17.61	17.14	15.68
	VPS	18.54	18.83	18.98	19.04	19.77	20.63	22.23	24.69	24.48	23.72	22.93	20.29
	CLD	62.00	60.62	45.00	64.77	75.41	81.00	75.00	62.25	69.59	63.97	63.88	57.81
28 N	SPD	4.86	5.66	5.68	6.73	6.08	6.14	5.57	5.72	6.88	4.91	5.78	6.69
119 W	AIR	16.37	16.01	16.09	16.09	16.73	17.37	19.07	19.94	19.68	19.13	18.74	16.95
	SEA	16.64	16.54	16.30	16.76	17.17	17.85	19.34	20.17	20.82	19.70	19.33	17.72
	VPA	14.26	14.24	13.93	14.51	14.97	15.70	18.42	18.98	19.13	16.85	16.82	15.26
	VPS	18.97	18.84	18.56	19.11	3.63	20.54	22.62	23.71	24.71	23.00	22.50	20.39
	CLD	57.95	57.40	70.67	67.43	82.55	85.71	81.14	75.50	70.25	55.74	52.50	50.96
28 N	SPD	5.70	7.63	5.72	6.37	6.43	5.97	5.88	5.60	5.12	5.31	5.37	6.85
120 W	AIR	15.68	15.54	16.12	16.03	16.58	17.38	18.75	19.04	19.88	20.13	18.00	16.98
	SEA	17.74	16.89	17.09	17.15	16.92	17.69	18.86	19.62	20.50	20.26	18.92	17.60
	VPA	12.56	13.82	13.52	13.56	14.88	15.95	17.58	17.75	17.93	18.08	16.08	14.15
	VPS	20.59	19.27	19.52	19.63	19.32	20.29	21.87	22.88	24.17	23.83	21.92	20.23
	CLD	68.75	61.45	65.72	73.12	75.00	86.69	80.00	82.95	70.83	45.23	60.86	51.56
28 N	SPD	6.48	5.98	6.83	6.69	5.31	6.58	5.76	5.63	5.68	4.79	5.04	5.92
121 W	AIR	16.44	16.38	16.91	16.22	17.15	17.58	18.75	19.36	19.97	19.41	18.26	17.29
	SEA	17.23	16.83	16.94	17.07	17.68	17.81	19.42	19.67	20.40	20.35	19.57	18.08
	VPA	15.06	15.51	14.36	14.34	14.16	15.49	17.80	18.18	18.33	17.81	15.83	15.07
	VPS	19.70	19.24	19.39	19.49	20.46	20.43	22.60	22.97	24.04	23.97	22.82	20.86
	CLD	42.50	62.50	60.41	53.30	69.90	80.88	79.16	87.85	69.19	68.53	57.29	52.34
28 N	SPD	5.40	5.23	6.45	7.15	7.20	6.43	5.54	5.53	5.27	6.06	4.27	6.03
122 W	AIR	15.52	16.32	15.44	15.72	16.94	17.24	18.52	19.87	19.46	19.26	18.08	17.24
	SEA	17.12	17.55	16.69	16.63	17.23	17.98	19.23	20.13	20.20	19.70	18.96	18.09
	VPA	13.71	14.97	12.89	14.01	14.96	15.45	17.01	18.78	17.96	17.38	16.93	14.47
	VPS	19.57	20.10	19.07	18.95	19.71	20.65	22.33	23.75	23.74	23.07	21.96	20.80
	CLD	70.98	57.63	58.92	55.26	80.85	85.54	92.14	75.33	69.82	55.97	53.90	56.81
28 N	SPD	6.44	5.79	6.55	6.70	6.71	6.34	6.04	6.53	5.66	5.27	5.94	6.21
123 W	AIR	15.70	15.92	15.82	16.51	17.24	17.62	19.03	19.65	20.10	19.18	18.24	16.60
	SEA	17.26	17.34	17.02	16.64	17.32	18.44	19.42	19.95	20.63	20.64	19.36	18.33
	VPA	13.42	14.31	12.93	14.35	14.71	15.95	18.03	18.55	18.92	17.72	16.04	14.45
	VPS	19.78	19.83	19.42	19.00	19.81	21.26	22.77	23.35	24.59	24.40	22.53	21.11
	CLD	58.79	65.10	70.67	77.56	75.00	80.00	83.45	74.03	66.37	65.31	68.24	65.62
28 N	SPD	5.91	5.58	7.34	6.47	6.32	6.24	6.55	6.34	5.51	5.41	6.22	5.84
124 W	AIR	15.40	16.22	16.39	16.35	17.28	17.69	18.59	20.04	19.87	19.40	18.41	17.13
	SEA	17.25	17.59	17.34	17.27	17.45	17.98	19.04	20.14	20.44	20.60	19.60	18.62
	VPA	14.03	14.64	13.37	14.58	14.26	16.45	17.08	18.99	17.87	18.25	16.73	14.71
	VPS	19.75	20.13	19.85	19.81	19.98	20.73	22.07	23.70	24.11	24.37	22.85	21.51
	CLD	62.87	73.12	69.23	70.56	78.94	77.70	86.39	75.80	72.05	54.44	66.28	63.79

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
29 N	SPD	6.25	6.10	7.35	7.17	8.05	6.23	6.39	5.98	6.58	6.19	5.58	5.73
115 W	AIR	15.88	16.08	15.37	15.87	16.13	16.50	18.65	20.10	20.13	19.18	17.78	17.33
	SEA	16.54	16.28	15.42	15.84	15.70	16.37	18.30	20.11	20.47	19.65	19.02	18.05
	VPA	13.95	14.31	13.41	14.39	14.97	16.03	18.85	19.74	19.74	18.20	16.26	14.69
	VPS	18.88	18.60	17.56	18.10	17.94	18.71	21.15	23.81	24.25	23.04	22.15	20.83
	CLD	40.88	43.65	48.23	59.95	52.03	79.07	62.21	53.19	59.29	41.66	43.75	37.75
29 N	SPD	5.63	6.00	6.85	6.78	7.02	6.31	5.83	5.59	6.23	5.92	5.80	5.90
116 W	AIR	15.81	15.78	15.75	16.16	16.57	17.22	18.78	20.31	20.63	19.55	18.36	16.82
	SEA	16.44	16.10	15.66	16.02	16.39	17.03	18.78	20.34	20.71	20.06	18.86	17.66
	VPA	13.87	13.79	13.66	14.43	14.91	16.14	18.57	20.03	20.28	18.49	16.66	14.76
	VPS	18.78	18.37	17.86	18.27	18.71	19.48	21.78	24.02	24.57	23.59	21.89	20.31
	CLD	43.79	44.00	56.37	59.20	71.84	80.74	75.01	66.44	57.49	53.50	44.16	44.88
29 N	SPD	5.36	5.97	6.77	6.56	6.87	6.57	5.92	5.37	5.83	5.82	5.60	5.79
117 W	AIR	15.84	15.75	15.67	16.06	16.76	17.36	18.65	20.52	20.61	19.88	18.33	16.62
	SEA	16.32	16.05	15.87	16.02	16.76	17.40	18.76	20.36	20.84	20.24	18.83	17.24
	VPA	14.14	14.04	13.96	14.52	15.00	16.19	18.16	19.97	20.02	18.81	16.50	14.45
	VPS	18.62	18.29	18.09	18.25	19.16	19.92	21.72	24.00	24.76	23.83	21.81	19.77
	CLD	44.09	53.54	55.40	64.21	71.59	85.03	78.85	70.54	58.41	48.88	47.67	50.64
29 N	SPD	4.81	5.51	5.80	6.61	6.08	6.23	5.71	4.98	4.73	5.89	4.94	5.87
118 W	AIR	16.76	16.24	16.12	15.92	16.58	17.73	18.52	20.16	20.00	19.02	18.70	16.63
	SEA	16.16	16.15	16.05	16.04	17.16	17.58	18.73	20.57	20.56	19.53	19.28	17.57
	VPA	14.24	14.55	13.90	14.63	14.49	16.54	18.19	20.21	19.03	18.17	16.66	14.95
	VPS	18.39	18.38	18.30	18.25	19.60	20.13	21.65	24.34	24.29	22.76	22.40	20.16
	CLD	47.05	48.25	59.32	58.89	55.63	77.90	66.07	55.27	59.37	46.96	43.05	39.91
29 N	SPD	4.97	4.78	6.87	6.08	6.48	6.40	4.51	5.92	6.81	5.86	5.12	6.92
119 W	AIR	15.70	16.26	16.01	15.77	16.66	17.40	18.51	20.08	19.35	19.20	17.27	16.67
	SEA	17.00	16.29	15.98	16.23	16.91	17.24	18.46	19.96	20.46	19.74	18.61	18.06
	VPA	14.70	14.01	14.02	13.80	14.91	16.17	17.80	19.67	18.61	18.47	14.63	13.52
	VPS	19.47	18.55	18.28	18.47	19.29	19.72	21.35	23.40	24.12	23.06	21.48	20.80
	CLD	55.83	67.64	73.07	81.48	72.42	68.96	87.13	72.91	61.33	39.94	61.93	66.87
29 N	SPD	3.98	5.47	5.87	7.27	6.30	6.44	6.05	5.63	5.89	5.82	5.17	5.44
120 W	AIR	16.16	15.83	15.47	16.03	16.52	17.64	18.12	18.91	19.11	18.78	18.64	16.33
	SEA	16.42	16.40	15.44	16.39	17.11	17.47	18.27	19.37	19.56	19.08	18.48	18.20
	VPA	13.35	14.58	13.35	13.88	14.71	16.05	17.04	17.54	17.84	17.17	16.40	13.99
	VPS	18.70	18.77	17.61	18.79	19.57	20.03	21.04	22.54	22.83	22.21	21.33	20.93
	CLD	57.23	65.00	59.55	64.66	74.71	70.83	85.97	85.49	72.81	61.29	44.02	66.37
29 N	SPD	5.61	6.06	5.66	7.41	6.36	6.00	6.04	6.28	5.66	5.46	4.87	5.12
121 W	AIR	15.72	15.95	16.69	15.47	16.49	17.28	18.31	19.08	19.33	19.02	18.16	16.68
	SEA	16.79	15.90	16.60	16.52	16.46	17.38	18.33	19.31	19.77	19.71	18.83	17.27
	VPA	13.48	14.16	15.03	13.94	14.24	15.25	17.23	17.85	17.99	17.32	15.98	13.92
	VPS	19.19	18.11	18.97	18.85	18.79	19.90	21.15	22.44	23.11	23.02	21.81	19.76
	CLD	69.03	63.04	54.83	67.43	68.88	78.57	82.84	79.48	76.38	62.50	54.04	59.25
29 N	SPD	6.27	6.82	7.78	7.13	6.63	5.85	6.84	5.98	6.12	6.36	5.76	6.40
122 W	AIR	15.99	15.54	15.10	15.85	16.19	17.06	18.71	19.17	19.71	19.05	17.70	16.10
	SEA	16.48	15.98	16.23	16.72	16.62	17.22	19.06	19.30	19.97	20.05	18.83	17.59
	VPA	13.84	14.46	13.42	13.96	14.48	15.56	17.85	18.02	18.59	17.73	16.10	14.72
	VPS	18.81	18.20	18.49	19.08	18.94	19.73	22.10	22.44	23.41	23.55	21.80	20.15
	CLD	55.55	64.93	61.84	60.55	76.13	74.32	82.55	79.16	63.19	61.40	56.61	62.93
29 N	SPD	7.22	6.00	6.19	6.38	6.79	6.88	6.93	6.48	5.87	5.51	5.19	5.64
123 W	AIR	15.40	15.59	15.99	15.65	16.56	17.16	18.41	18.99	19.11	19.09	17.82	16.23
	SEA	16.70	16.68	16.79	16.78	16.93	17.28	18.73	19.26	19.78	19.84	18.64	17.65
	VPA	13.14	13.52	13.36	13.78	14.23	15.54	17.41	17.56	17.69	17.27	15.89	14.86
	VPS	19.06	19.05	19.16	19.15	19.37	19.76	21.65	22.38	23.11	23.22	21.60	20.24
	CLD	66.07	71.52	70.50	72.00	75.85	69.07	85.50	78.27	75.30	55.88	74.40	75.52
29 N	SPD	6.10	5.17	6.69	6.88	6.82	6.49	7.41	5.97	5.64	6.69	5.51	5.57
124 W	AIR	15.55	17.02	15.80	15.36	16.25	17.30	18.10	19.02	20.03	18.66	17.92	16.17
	SEA	16.78	16.90	16.54	16.62	16.69	17.43	18.39	19.48	20.36	19.55	18.86	17.74
	VPA	14.07	15.07	13.62	13.31	14.31	15.94	16.50	18.03	17.63	16.76	16.22	13.64
	VPS	19.19	19.31	18.86	18.95	19.03	19.96	21.21	22.70	24.10	22.79	21.86	20.40
	CLD	66.37	71.25	63.12	65.94	70.83	80.40	84.37	87.12	72.76	76.20	59.21	67.70

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
30 N	SPD	5.50	5.49	6.35	6.42	6.48	5.99	5.49	5.35	5.68	5.82	5.25	5.60
116 W	AIR	15.54	15.36	15.27	15.82	16.20	16.71	18.38	19.87	19.98	19.20	17.92	16.28
	SEA	16.22	15.88	15.58	15.84	16.27	16.91	18.50	20.09	20.08	19.54	18.46	17.12
	VPA	13.66	13.55	13.46	14.34	14.69	15.86	18.17	19.78	19.53	18.18	16.34	14.52
	VPS	18.51	18.10	17.76	18.06	18.58	19.34	21.40	23.65	23.64	22.86	21.33	19.64
	CLD	47.40	48.00	51.63	57.58	70.38	83.33	77.47	72.13	60.96	57.12	46.22	44.21
30 N	SPD	5.12	5.47	6.46	6.75	6.63	6.06	5.72	5.28	5.73	5.46	5.34	5.64
117 W	AIR	15.37	15.21	15.40	15.75	16.06	16.96	18.31	19.82	20.16	19.33	17.90	16.07
	SEA	16.11	15.76	15.65	16.07	16.37	17.04	18.59	20.22	20.42	19.81	18.44	17.05
	VPA	13.36	13.58	13.49	14.03	14.52	15.98	17.79	19.40	19.76	18.01	16.19	14.34
	VPS	18.38	17.96	17.85	18.31	18.67	19.49	21.50	23.79	24.10	23.21	21.30	19.52
	CLD	45.49	50.00	54.82	60.00	72.30	81.99	80.86	71.06	58.15	54.57	48.31	47.11
30 N	SPD	5.52	5.72	6.19	6.53	6.77	6.99	6.04	5.06	5.99	5.30	5.19	5.62
118 W	AIR	15.10	15.40	15.22	15.32	15.92	17.09	17.53	19.93	19.71	19.04	17.78	15.95
	SEA	15.81	15.55	15.46	15.87	16.40	16.96	18.10	20.49	19.80	19.58	18.22	17.01
	VPA	13.59	13.65	13.26	13.99	14.67	15.88	17.04	19.79	19.15	18.21	16.08	14.07
	VPS	18.04	17.72	17.62	18.10	18.70	19.38	20.86	24.49	23.17	22.86	20.99	19.50
	CLD	50.48	51.83	56.29	59.32	75.29	79.19	85.92	76.11	50.90	50.36	47.30	46.73
30 N	SPD	6.33	5.74	7.49	6.44	7.52	6.67	4.55	6.24	5.92	5.69	6.10	5.64
119 W	AIR	15.16	14.81	14.53	15.37	16.20	16.55	17.82	18.20	19.12	18.68	17.49	15.90
	SEA	15.66	15.41	15.01	16.06	16.20	16.78	18.01	19.25	19.51	19.55	18.22	17.72
	VPA	13.25	13.15	12.44	14.01	14.62	15.65	17.75	17.26	17.83	17.89	15.61	13.95
	VPS	17.84	17.57	17.10	18.29	18.49	19.17	20.77	22.42	22.78	22.80	20.96	20.31
	CLD	51.53	44.01	49.35	59.78	67.30	83.75	72.87	76.29	64.94	48.50	54.51	56.25
30 N	SPD	6.57	5.58	6.11	6.70	7.09	6.64	6.27	6.22	5.68	5.70	5.58	5.91
120 W	AIR	14.64	16.40	16.98	15.02	15.64	16.84	17.30	18.08	18.82	18.09	16.59	16.87
	SEA	16.06	15.58	15.55	15.70	16.71	17.09	17.92	19.28	19.39	19.31	18.19	17.83
	VPA	13.04	15.23	15.68	13.50	14.16	16.46	16.14	17.41	17.92	17.35	14.25	15.06
	VPS	18.31	17.76	17.70	17.87	19.11	19.54	20.62	22.48	22.58	22.46	20.94	20.47
	CLD	51.00	55.97	63.26	59.82	65.33	79.23	79.16	81.25	59.44	61.41	74.50	58.53
30 N	SPD	6.02	6.31	6.65	7.90	7.27	6.56	5.88	6.66	6.43	6.26	5.41	7.42
121 W	AIR	15.40	15.23	15.59	14.97	15.74	16.79	17.22	18.50	19.01	18.62	17.47	16.84
	SEA	16.08	15.24	15.60	15.62	15.96	16.86	17.70	18.81	18.90	19.24	17.97	17.79
	VPA	12.94	14.38	13.92	12.85	14.27	16.21	16.75	17.62	17.76	16.97	15.95	14.68
	VPS	18.34	17.39	17.79	17.77	18.23	19.26	20.32	21.75	21.91	22.40	20.66	20.40
	CLD	60.00	61.66	58.88	60.99	67.04	81.99	85.00	85.71	66.98	56.89	62.50	68.18
30 N	SPD	4.96	7.87	6.83	7.45	7.25	7.32	6.34	7.27	6.75	6.32	6.01	5.96
122 W	AIR	15.16	15.34	15.17	15.53	15.98	16.95	17.25	18.40	18.61	18.29	17.47	15.71
	SEA	16.32	15.79	16.04	15.59	16.10	17.12	17.52	18.67	19.15	18.94	18.57	16.79
	VPA	13.07	14.35	13.16	13.83	14.26	15.72	16.70	17.70	17.21	16.33	16.52	14.01
	VPS	18.62	18.03	18.27	17.75	18.35	19.59	20.07	21.61	22.26	21.97	21.45	19.16
	CLD	73.72	61.18	66.55	63.88	62.03	75.84	82.14	79.68	74.75	62.78	63.14	73.52
30 N	SPD	5.66	7.88	7.10	7.98	7.56	7.29	6.21	6.29	6.27	7.07	5.72	6.13
123 W	AIR	14.44	15.69	15.11	15.18	15.70	16.51	17.89	18.70	19.36	18.11	17.30	16.16
	SEA	15.85	15.85	15.96	15.90	16.11	16.78	18.29	19.30	19.64	19.06	18.28	17.32
	VPA	12.72	13.98	13.20	13.31	14.11	15.52	16.74	17.63	17.90	16.56	15.44	13.82
	VPS	18.09	18.06	18.20	18.11	18.33	19.16	21.12	22.43	22.99	22.09	21.08	19.84
	CLD	76.95	52.88	66.93	55.68	85.99	78.90	87.25	75.91	69.47	60.64	57.37	72.91
30 N	SPD	6.70	7.10	6.03	7.13	7.78	6.71	7.08	6.19	5.81	6.84	5.59	6.33
124 W	AIR	15.14	14.75	15.02	14.91	15.99	16.55	17.55	18.90	19.34	18.45	17.89	16.04
	SEA	16.67	16.05	16.00	16.24	16.69	17.16	18.24	19.10	19.90	19.83	18.92	17.42
	VPA	13.63	12.78	13.44	12.77	14.30	14.98	16.44	17.47	17.73	16.64	15.78	13.48
	VPS	19.04	18.31	18.23	18.52	19.07	19.62	21.02	22.21	23.34	23.23	21.90	19.94
	CLD	69.88	63.63	61.32	68.88	77.96	82.47	83.13	72.79	76.47	71.15	59.93	59.25
30 N	SPD	7.46	7.09	6.73	7.22	7.56	7.06	6.32	6.94	5.81	6.12	5.99	6.00
125 W	AIR	15.37	15.25	15.50	15.03	16.33	16.96	17.61	19.14	19.33	18.79	18.42	16.39
	SEA	16.88	16.08	16.30	16.08	16.52	17.42	17.90	18.96	19.81	19.46	19.26	17.88
	VPA	13.69	14.32	13.95	12.67	14.30	15.90	16.01	18.19	17.84	17.04	16.06	14.35
	VPS	19.29	18.35	18.56	18.36	18.88	19.99	20.56	21.99	23.23	22.67	22.43	20.56
	CLD	75.00	74.71	60.19	68.20	78.37	76.95	85.27	81.39	66.21	72.02	72.15	71.48

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
31 N	SPD	4.72	5.38	5.92	5.94	5.97	5.60	5.29	5.21	5.32	5.03	5.05	5.14
117 W	AIR	15.15	15.00	14.86	15.27	15.84	16.48	18.00	19.39	19.60	18.95	17.47	15.83
	SEA	15.68	15.48	15.23	15.79	16.40	17.01	18.60	20.09	20.14	19.43	18.08	16.78
	VPA	13.34	13.29	13.20	13.80	14.51	15.64	17.79	18.91	19.16	17.91	15.91	14.05
	VPS	17.89	17.65	17.37	17.99	18.71	19.47	21.54	23.61	23.70	22.68	20.82	19.21
	CLD	40.16	48.11	47.67	56.43	70.41	81.00	77.73	68.89	59.27	54.84	44.06	44.05
31 N	SPD	5.41	6.11	6.72	6.67	6.31	6.09	5.57	5.59	6.06	5.71	5.87	5.86
118 W	AIR	14.81	14.94	14.84	15.00	15.74	16.38	17.03	18.41	19.30	18.61	17.21	15.72
	SEA	15.46	15.29	15.09	15.50	16.15	16.59	17.87	19.47	19.66	19.25	18.05	16.91
	VPA	13.42	13.36	13.16	13.68	14.48	15.51	16.65	17.95	18.47	17.24	15.49	13.87
	VPS	17.65	17.43	17.20	17.68	18.41	18.95	20.57	22.72	22.97	22.39	20.80	19.35
	CLD	45.79	48.47	55.22	57.69	78.21	80.69	85.83	73.73	55.54	50.43	49.23	49.63
31 N	SPD	5.72	6.45	7.26	7.22	6.79	7.27	6.26	6.31	6.00	5.96	5.62	5.79
119 W	AIR	14.84	14.35	14.34	14.61	15.25	16.09	16.69	17.54	18.69	18.55	17.25	15.11
	SEA	15.30	14.68	14.89	15.31	15.83	16.46	16.95	18.98	19.09	19.05	17.94	16.25
	VPA	13.19	13.08	12.96	13.22	13.96	14.96	16.35	17.30	18.12	17.58	15.39	13.56
	VPS	17.45	16.75	16.99	17.44	18.04	18.77	19.43	22.04	22.17	22.11	20.63	18.58
	CLD	48.71	47.50	53.57	61.75	68.93	74.31	80.20	71.08	52.73	47.56	51.43	51.09
31 N	SPD	6.43	6.51	6.58	7.49	7.40	7.25	7.09	6.13	6.81	5.68	5.82	4.47
120 W	AIR	14.95	14.93	14.87	14.42	15.43	16.20	16.86	17.25	18.54	17.77	17.34	15.63
	SEA	15.70	15.27	14.95	15.42	15.65	16.46	17.08	18.13	18.96	19.04	17.99	16.51
	VPA	12.69	13.64	13.70	12.31	14.25	15.80	15.76	16.59	17.69	16.73	16.50	14.39
	VPS	17.89	17.41	17.04	17.55	17.82	18.79	19.58	20.89	22.02	22.09	20.69	18.84
	CLD	43.85	58.04	54.58	66.66	73.67	76.98	82.81	78.84	47.07	60.29	48.38	56.87
31 N	SPD	6.54	6.79	6.63	7.26	7.86	7.80	7.53	6.29	7.68	6.53	5.46	6.07
121 W	AIR	14.56	14.76	14.57	14.13	15.18	16.13	16.53	17.43	18.10	17.89	16.98	15.81
	SEA	15.68	15.03	14.84	15.12	15.59	16.32	16.85	18.10	18.98	18.95	16.94	16.77
	VPA	12.68	13.76	13.49	12.08	13.94	15.49	15.94	16.68	17.38	16.94	15.71	14.03
	VPS	17.87	17.15	16.92	17.24	17.76	18.60	19.29	20.85	22.05	21.98	19.37	19.15
	CLD	60.75	62.26	62.66	66.75	69.38	62.50	81.38	83.33	51.81	65.72	47.50	58.26
31 N	SPD	5.77	7.86	7.19	8.89	7.40	7.56	6.86	6.81	7.36	6.48	6.23	6.38
122 W	AIR	14.72	15.06	14.72	14.69	15.06	16.10	17.00	18.13	18.12	17.83	16.86	15.87
	SEA	15.67	14.86	14.95	15.25	15.46	16.58	17.43	17.92	18.96	18.47	17.42	16.93
	VPA	13.43	13.80	13.26	12.50	13.68	15.53	16.19	17.32	17.04	16.62	15.56	14.12
	VPS	17.87	16.99	17.05	17.39	17.61	18.95	19.99	20.58	22.00	21.34	20.00	19.37
	CLD	60.28	60.91	58.82	60.18	76.29	67.08	80.92	83.62	75.39	68.05	59.60	63.25
31 N	SPD	6.65	7.26	6.49	7.34	7.28	7.50	7.19	6.95	6.68	7.01	5.89	6.86
123 W	AIR	14.81	14.56	14.54	14.78	15.50	16.72	17.29	18.31	18.65	17.60	17.09	15.77
	SEA	15.96	15.56	15.27	15.79	15.84	16.83	17.58	18.50	19.09	18.29	17.94	16.98
	VPA	13.13	13.30	12.68	13.05	13.97	15.39	16.25	17.44	17.37	16.03	15.52	14.60
	VPS	18.19	17.77	17.40	18.00	18.09	19.24	20.16	21.34	22.19	21.08	20.65	19.41
	CLD	67.39	63.36	62.89	69.36	62.67	72.47	82.35	77.24	76.27	66.80	59.83	69.53
31 N	SPD	6.72	6.70	7.32	7.80	7.37	8.20	6.67	6.70	6.80	6.64	5.73	6.94
124 W	AIR	14.90	14.94	14.85	14.52	15.54	16.59	17.48	18.20	18.77	18.19	17.44	15.65
	SEA	15.75	15.63	15.36	15.52	15.92	16.76	17.47	18.53	19.37	18.87	18.15	16.84
	VPA	13.41	13.07	13.01	13.10	13.47	15.35	16.56	17.64	17.64	16.56	15.51	14.46
	VPS	17.93	17.81	17.52	17.69	18.15	19.13	20.02	21.46	22.58	21.88	20.89	19.25
	CLD	75.35	59.16	67.10	69.02	62.50	76.92	85.87	69.31	65.97	60.44	62.50	68.54
31 N	SPD	6.70	7.36	6.07	8.22	7.07	7.35	6.78	7.71	6.29	7.34	6.90	6.84
125 W	AIR	15.15	14.95	14.82	15.16	15.58	16.75	17.43	18.67	19.23	18.52	17.50	15.84
	SEA	15.99	15.73	15.87	15.66	16.22	16.89	17.91	18.75	19.76	19.17	18.50	17.25
	VPA	13.67	13.68	13.05	13.08	13.81	15.25	16.67	17.79	17.49	16.72	15.52	14.25
	VPS	18.24	17.96	18.08	17.85	18.52	19.31	20.59	21.70	23.12	22.32	21.39	19.74
	CLD	73.01	72.22	72.41	72.29	73.61	79.63	86.48	69.49	71.31	67.15	59.96	65.88
31 N	SPD	6.61	7.79	7.07	7.25	6.58	7.10	7.22	6.56	5.75	6.36	7.05	6.87
126 W	AIR	15.48	14.82	14.99	14.89	15.64	16.77	17.37	18.90	19.29	18.75	17.57	16.30
	SEA	16.23	15.61	15.73	15.66	16.49	17.33	18.04	19.09	19.73	19.42	18.55	17.05
	VPA	14.04	13.30	13.11	13.07	13.83	15.64	16.18	17.70	17.79	16.89	15.59	14.68
	VPS	18.51	17.80	17.93	17.86	18.83	19.85	20.77	22.24	23.08	22.63	21.42	19.54
	CLD	73.68	69.29	66.05	66.88	73.43	77.53	89.04	70.98	69.57	69.74	63.01	67.20

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
32 N	SPD	4.23	4.36	4.67	4.98	4.45	3.93	4.14	4.03	4.28	4.46	4.19	4.66
117 W	AIR	14.57	14.58	14.93	15.32	16.19	17.19	18.74	19.99	19.76	18.86	17.45	15.71
	SEA	14.95	14.59	15.01	15.57	16.31	17.31	19.09	20.07	19.79	19.06	17.75	16.41
	VPA	12.74	12.81	12.94	13.58	14.40	16.02	18.06	19.44	19.07	17.56	15.67	13.71
	VPS	17.08	16.69	17.15	17.78	18.64	19.86	22.23	23.61	23.21	22.17	20.41	18.77
	CLD	46.27	45.39	49.32	57.37	62.99	75.70	70.83	60.90	58.10	52.71	43.82	44.91
32 N	SPD	5.09	5.07	5.63	5.74	5.39	4.90	5.10	4.97	5.14	5.10	5.12	5.16
118 W	AIR	14.14	14.46	14.44	14.82	15.18	16.12	17.32	18.73	18.79	18.26	17.19	15.45
	SEA	14.73	14.69	15.01	15.39	15.94	16.89	18.33	19.70	19.49	19.15	17.74	16.45
	VPA	12.53	12.76	12.83	13.26	13.82	15.17	16.83	18.21	18.02	16.93	15.23	13.49
	VPS	16.85	16.80	17.14	17.56	18.20	19.31	21.17	23.07	22.73	22.28	20.41	18.81
	CLD	48.51	48.93	52.68	56.23	70.88	80.58	75.97	68.28	58.16	52.83	44.37	46.37
32 N	SPD	5.78	6.56	7.10	6.97	6.80	6.69	6.39	6.27	6.32	5.72	5.87	5.93
119 W	AIR	14.19	14.07	13.81	14.27	14.60	15.49	16.36	17.62	18.02	17.97	16.45	15.00
	SEA	14.63	14.73	14.53	14.91	15.30	16.10	17.22	18.97	18.98	18.80	17.21	16.09
	VPA	12.68	12.62	12.45	12.79	13.68	14.85	16.08	17.10	17.49	16.83	14.54	13.08
	VPS	16.75	16.83	16.59	17.03	17.46	18.39	19.75	22.05	22.03	21.79	19.74	18.39
	CLD	51.04	44.16	53.39	60.77	72.00	75.18	80.37	74.18	56.71	50.67	44.49	47.54
32 N	SPD	5.80	7.15	7.48	8.21	7.68	7.30	7.47	6.81	7.04	6.94	6.13	6.04
120 W	AIR	14.13	14.01	13.85	14.07	14.68	15.31	16.04	16.73	17.93	17.65	16.61	14.93
	SEA	14.88	14.79	14.49	14.74	15.01	15.59	16.30	17.93	18.68	18.55	17.19	16.02
	VPA	12.96	12.90	12.60	12.72	13.78	14.67	15.74	16.64	17.25	16.48	15.28	13.70
	VPS	16.99	16.88	16.55	16.84	17.12	17.78	18.62	20.64	21.64	21.44	19.69	18.28
	CLD	58.63	47.04	49.21	56.83	67.03	72.15	74.30	79.87	54.50	48.19	55.24	49.28
32 N	SPD	6.93	7.64	7.49	7.82	7.65	7.84	7.65	7.28	7.13	6.63	6.96	6.51
121 W	AIR	14.20	13.74	14.01	14.02	14.63	15.35	16.14	17.09	17.61	17.37	16.44	15.18
	SEA	15.03	14.90	14.84	14.89	15.20	15.92	16.49	17.63	18.43	18.40	17.25	16.26
	VPA	13.21	12.86	12.76	12.73	13.59	14.83	15.83	16.72	16.79	16.42	15.51	14.03
	VPS	17.14	17.01	16.93	16.99	17.35	18.15	18.83	20.25	21.32	21.25	19.75	18.54
	CLD	55.90	55.55	57.65	59.07	65.70	73.50	78.80	76.92	61.36	58.16	57.02	54.58
32 N	SPD	6.66	8.10	8.42	8.32	8.96	8.41	7.64	7.83	7.12	6.46	6.35	7.04
122 W	AIR	14.56	14.03	13.82	14.30	14.45	15.65	16.49	17.33	18.11	17.68	16.30	15.07
	SEA	15.22	14.78	14.72	14.93	15.04	15.97	16.83	17.73	18.60	18.50	17.19	15.99
	VPA	13.39	12.97	12.40	12.88	13.19	14.97	16.00	16.81	17.01	16.89	14.87	13.55
	VPS	17.35	16.90	16.80	17.03	17.17	18.23	19.25	20.39	21.52	21.41	19.67	18.26
	CLD	57.06	62.25	63.89	63.55	69.29	72.72	84.30	77.86	59.22	55.61	48.47	56.47
32 N	SPD	6.62	7.44	8.02	8.68	8.50	7.73	6.94	7.68	6.36	7.32	6.70	7.63
123 W	AIR	14.62	14.03	13.73	14.47	14.63	15.88	16.82	17.48	17.99	17.60	16.60	15.03
	SEA	15.44	14.76	14.80	14.99	15.32	16.47	17.00	18.08	18.93	18.51	17.29	16.24
	VPA	13.52	12.69	12.02	13.08	13.36	14.81	16.01	17.04	17.38	16.09	15.12	13.79
	VPS	17.58	16.85	16.89	17.12	17.48	18.79	19.46	20.79	21.98	21.41	19.83	18.53
	CLD	63.68	62.67	65.03	67.36	70.33	77.78	83.79	75.78	66.94	56.41	58.79	62.50
32 N	SPD	6.81	7.59	6.55	8.66	7.49	7.60	6.92	7.01	6.80	6.89	6.32	6.03
124 W	AIR	14.94	14.65	14.65	14.93	15.59	16.86	17.68	18.49	18.73	18.10	16.38	15.72
	SEA	15.48	15.09	15.21	15.18	15.95	17.76	18.06	17.77	19.21	18.55	17.09	16.15
	VPA	13.68	13.33	12.86	13.56	13.64	15.89	17.04	17.19	17.69	16.44	14.87	14.13
	VPS	17.64	17.19	17.33	17.29	18.17	20.45	20.79	20.43	22.35	21.46	19.55	18.41
	CLD	65.01	65.38	61.03	67.31	69.50	77.64	77.33	79.18	67.42	63.73	61.57	54.34
32 N	SPD	6.59	7.35	7.29	7.79	7.42	7.81	7.35	6.91	6.34	6.67	6.59	7.00
125 W	AIR	14.80	14.44	14.20	14.66	15.23	16.55	17.31	18.35	18.99	18.15	16.83	15.40
	SEA	15.72	15.10	14.90	15.12	15.83	16.73	17.62	18.52	19.17	18.80	17.62	16.78
	VPA	13.91	13.28	12.58	13.03	13.60	15.65	16.62	17.63	17.53	16.85	15.31	13.90
	VPS	17.91	17.22	17.02	17.25	18.06	19.11	20.22	21.40	22.31	21.79	20.23	19.18
	CLD	68.58	69.79	68.11	67.34	69.73	77.07	80.11	78.94	65.62	65.90	63.15	63.82
32 N	SPD	6.67	7.35	7.61	7.89	7.31	7.33	7.78	6.82	5.94	6.33	6.66	6.98
126 W	AIR	14.98	14.38	14.50	14.34	15.32	16.85	17.34	18.54	19.02	18.50	17.11	15.85
	SEA	16.03	15.38	15.10	15.35	15.98	17.14	17.75	18.81	19.52	19.11	17.96	17.11
	VPA	13.84	13.03	12.86	12.90	13.87	15.47	16.43	17.44	17.72	16.61	15.48	14.41
	VPS	18.28	17.54	17.20	17.49	18.23	19.64	20.37	21.78	22.82	22.20	20.67	19.60
	CLD	68.81	64.37	70.13	70.01	71.81	71.09	84.50	76.03	66.16	65.82	67.57	70.33

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
33 N	SPD	4.52	4.93	5.19	5.16	4.84	4.38	4.44	4.45	4.45	4.24	4.59	4.82
118 W	AIR	14.51	14.61	14.52	15.15	15.75	16.78	18.16	19.55	19.38	18.53	17.04	15.10
	SEA	15.00	15.09	15.01	15.48	16.37	17.50	18.77	20.34	19.89	19.09	17.61	16.08
	VPA	12.26	12.53	12.62	13.30	14.17	15.65	17.58	19.04	18.55	17.08	14.81	12.55
	VPS	17.12	17.21	17.13	17.66	18.70	20.09	21.80	23.99	23.32	22.20	20.24	18.35
	CLD	48.06	48.09	49.06	51.61	61.64	69.92	61.18	56.59	49.80	47.02	43.28	45.66
33 N	SPD	5.40	5.98	6.36	6.52	6.37	5.79	5.50	5.39	5.52	5.20	5.44	5.50
119 W	AIR	14.21	14.25	14.03	14.14	14.89	15.72	16.84	17.97	18.24	17.80	16.47	15.17
	SEA	14.73	14.84	14.66	14.70	15.42	16.47	17.98	19.14	19.12	18.56	17.05	15.87
	VPA	12.37	12.66	12.57	12.70	13.78	14.99	16.51	17.50	17.44	16.46	14.57	12.98
	VPS	16.83	16.93	16.75	16.81	17.60	18.86	20.74	22.28	22.25	21.49	19.55	18.11
	CLD	45.11	46.93	47.43	48.47	56.59	67.39	71.07	64.27	56.01	46.14	41.88	40.81
33 N	SPD	6.04	7.10	7.71	7.98	8.05	7.71	7.12	7.63	7.22	6.42	6.52	6.71
120 W	AIR	13.91	13.56	13.60	13.53	14.28	15.03	15.80	16.81	17.45	17.18	16.05	14.67
	SEA	14.25	14.10	13.78	13.51	14.10	14.95	16.31	17.63	17.92	17.67	16.29	15.32
	VPA	12.75	12.73	12.37	12.49	13.48	14.40	15.56	16.57	16.85	16.37	14.68	12.92
	VPS	16.30	16.15	15.81	15.57	16.17	17.08	18.67	20.29	20.66	20.31	18.60	17.52
	CLD	41.48	42.60	50.70	53.60	59.93	69.07	75.74	67.34	54.09	51.23	41.45	43.81
33 N	SPD	7.18	7.62	8.69	8.78	8.69	8.05	7.31	7.63	7.61	6.82	6.84	7.16
121 W	AIR	13.50	13.26	13.16	13.61	13.98	15.14	15.84	16.31	17.49	16.70	15.73	14.12
	SEA	14.21	14.20	13.74	13.94	14.29	15.22	16.31	17.29	17.94	17.19	16.33	15.23
	VPA	12.44	12.39	12.21	12.83	13.42	14.53	15.66	16.24	17.01	16.11	14.90	13.08
	VPS	16.27	16.27	15.77	16.00	16.35	17.37	18.64	19.83	20.69	19.70	18.64	17.38
	CLD	44.75	49.87	52.78	55.20	64.41	70.36	80.22	80.32	63.55	51.81	45.10	48.75
33 N	SPD	6.92	7.52	8.57	8.95	8.00	8.45	8.43	7.58	7.19	7.19	7.10	6.95
122 W	AIR	13.54	13.52	13.35	13.82	14.30	15.43	15.89	16.78	17.42	17.08	15.81	14.71
	SEA	14.38	14.19	13.85	14.28	14.55	15.56	16.15	17.41	18.02	17.51	16.51	15.41
	VPA	12.89	12.51	12.20	12.81	13.38	14.88	15.67	16.45	16.65	16.06	14.68	13.81
	VPS	16.45	16.24	15.90	16.34	16.64	17.76	18.43	19.95	20.78	20.09	18.87	17.58
	CLD	52.00	55.26	55.05	57.15	64.85	71.61	81.04	72.82	65.11	55.31	48.41	53.11
33 N	SPD	7.28	7.44	8.42	8.52	8.42	8.00	7.28	7.50	6.82	6.79	6.71	7.39
123 W	AIR	14.09	13.65	13.37	14.53	14.76	15.65	16.44	17.22	17.88	17.46	16.23	14.50
	SEA	14.70	14.15	13.96	14.70	14.66	15.71	16.37	17.24	18.21	17.82	16.71	15.59
	VPA	13.00	12.80	12.17	13.06	13.55	14.88	15.83	16.71	16.88	16.42	14.78	13.25
	VPS	16.79	16.20	16.00	16.77	16.75	17.93	18.70	19.74	21.02	20.47	19.11	17.82
	CLD	58.26	64.11	64.51	60.95	65.32	71.15	82.00	75.49	66.29	56.49	56.94	56.02
33 N	SPD	6.98	7.48	7.41	8.74	7.59	8.24	7.97	7.21	6.48	7.15	7.16	6.99
124 W	AIR	14.22	13.91	13.88	14.09	15.14	15.99	16.86	17.79	18.32	17.78	16.33	15.22
	SEA	14.99	14.45	14.39	14.50	15.41	16.27	17.15	17.69	18.61	18.29	17.17	16.07
	VPA	13.08	12.62	12.68	12.86	13.51	15.01	16.13	17.16	17.17	16.52	14.89	13.91
	VPS	17.10	16.51	16.46	16.56	17.56	18.57	19.64	20.32	21.51	21.10	19.70	18.33
	CLD	63.60	59.32	64.84	65.11	74.79	71.91	79.72	82.21	65.36	61.56	62.29	63.28
33 N	SPD	6.69	7.17	7.89	8.00	7.63	8.31	7.44	7.36	6.65	6.89	6.82	7.28
125 W	AIR	14.55	14.25	14.01	14.25	15.33	16.37	17.13	17.91	18.62	18.13	16.78	15.37
	SEA	15.08	14.64	14.43	14.81	15.40	16.39	17.21	17.85	18.87	18.52	17.53	16.18
	VPA	13.72	13.21	12.40	12.79	13.78	15.19	16.25	17.06	17.39	16.56	15.12	13.83
	VPS	17.22	16.72	16.49	16.89	17.58	18.70	19.71	20.51	21.91	21.39	20.11	18.46
	CLD	70.12	68.39	66.12	66.66	67.97	75.94	86.39	77.97	69.35	60.43	61.05	62.39
33 N	SPD	7.08	6.96	7.86	8.06	7.03	7.41	7.74	7.71	6.62	6.68	6.88	6.76
126 W	AIR	14.58	14.06	13.95	14.37	15.03	16.32	17.26	18.19	18.97	18.01	16.78	15.26
	SEA	15.29	15.07	14.68	14.92	15.48	16.61	17.69	18.37	19.18	18.77	17.68	16.58
	VPA	13.34	12.89	12.62	13.07	13.48	15.47	16.25	17.45	17.55	16.88	15.25	13.82
	VPS	17.44	17.19	16.77	17.02	17.64	18.99	20.30	21.24	22.33	21.73	20.32	18.95
	CLD	66.61	67.64	66.37	64.15	72.93	78.49	74.82	69.36	70.74	66.57	62.06	67.39
33 N	SPD	7.39	6.78	7.43	7.77	7.78	7.33	6.98	6.53	6.97	6.04	6.84	6.98
127 W	AIR	14.84	14.69	13.87	14.37	15.52	16.85	17.61	18.46	19.20	19.07	17.10	15.72
	SEA	15.49	15.30	14.11	14.97	15.64	16.75	18.01	18.62	19.48	19.26	17.90	16.70
	VPA	13.73	13.59	12.64	12.71	13.59	15.79	16.91	17.70	17.81	17.36	15.45	14.28
	VPS	17.68	17.47	16.17	17.06	17.84	19.16	20.74	21.53	22.76	22.41	20.59	19.11
	CLD	67.00	66.55	72.63	67.12	68.96	79.36	79.72	68.44	64.06	62.50	59.57	61.64

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
34 N	SPD	4.97	4.66	5.09	5.14	5.31	4.57	4.29	4.32	4.58	4.46	4.80	4.64
119 W	AIR	14.08	13.99	14.14	15.17	15.53	16.66	17.85	18.85	18.84	18.48	16.65	15.40
	SEA	14.15	13.94	14.19	14.39	15.15	16.72	17.98	19.22	19.01	18.26	16.35	15.54
	VPA	11.74	11.92	12.65	13.99	14.33	15.64	17.56	18.47	18.11	16.70	14.65	12.88
	VPS	16.20	15.98	16.25	16.49	17.34	19.15	20.79	22.44	22.14	21.07	18.70	17.73
	CLD	43.69	43.37	41.37	38.50	44.05	54.96	53.03	48.96	41.04	39.26	37.72	40.67
34 N	SPD	5.32	6.61	7.25	7.41	8.13	7.14	5.80	7.57	6.25	5.67	6.12	6.12
120 W	AIR	13.52	13.29	13.32	13.32	13.63	14.81	16.08	16.82	17.22	17.17	15.46	14.60
	SEA	13.96	13.41	13.45	13.07	13.63	15.01	16.32	17.03	17.72	17.19	15.76	14.73
	VPA	12.06	12.14	12.27	12.55	12.97	14.32	15.89	16.65	16.41	16.19	14.03	13.13
	VPS	15.99	15.44	15.50	15.14	15.70	17.21	18.68	19.62	20.42	19.74	18.03	16.84
	CLD	43.19	41.52	38.22	39.71	42.19	57.13	61.84	53.74	41.29	40.68	36.98	37.58
34 N	SPD	6.65	6.78	8.09	8.45	8.27	8.03	8.04	8.10	7.61	7.15	6.66	6.47
121 W	AIR	13.43	13.04	13.02	13.20	13.43	14.72	15.24	16.07	16.63	16.47	15.27	14.15
	SEA	13.62	13.22	13.29	13.28	13.31	14.33	15.42	16.47	16.86	16.53	15.50	14.25
	VPA	12.18	11.88	12.13	12.33	12.94	14.29	15.05	15.62	16.12	15.78	14.24	12.82
	VPS	15.65	15.25	15.33	15.36	15.36	16.45	17.66	18.85	19.33	18.90	17.70	16.31
	CLD	40.04	42.67	46.20	48.43	59.54	59.98	73.61	69.79	55.80	42.92	45.39	47.65
34 N	SPD	7.11	7.64	7.25	8.06	8.21	8.10	8.23	7.09	7.25	7.93	7.47	6.10
122 W	AIR	13.50	13.07	13.30	13.27	14.08	14.90	15.86	16.66	17.02	16.69	15.41	14.15
	SEA	13.94	13.60	13.52	13.46	13.89	14.56	15.92	16.77	16.91	17.07	15.98	14.49
	VPA	12.87	12.14	12.33	12.52	13.15	14.48	15.73	16.38	16.45	15.82	13.98	13.20
	VPS	15.97	15.63	15.56	15.51	15.93	16.64	18.19	19.18	19.40	19.56	18.25	16.56
	CLD	46.50	56.66	55.01	56.37	65.86	61.79	80.94	67.33	58.30	50.19	45.10	58.82
34 N	SPD	7.20	7.92	8.05	8.05	8.97	8.22	8.34	7.95	7.12	7.38	7.50	6.64
123 W	AIR	13.52	13.41	13.47	13.51	14.62	15.27	16.25	16.68	17.44	16.86	15.48	14.32
	SEA	14.23	13.66	13.59	13.93	14.34	14.87	16.31	17.08	17.60	17.05	15.88	14.99
	VPA	12.71	12.46	12.58	12.18	13.45	14.74	15.72	16.28	16.76	16.05	14.10	13.31
	VPS	16.32	15.71	15.63	15.99	16.42	16.99	18.61	19.55	20.23	19.51	18.14	17.11
	CLD	58.30	60.24	48.43	60.18	71.07	62.12	72.33	73.84	62.37	57.19	47.66	59.26
34 N	SPD	6.89	7.46	7.16	8.13	8.83	8.08	8.70	7.82	6.94	7.34	6.55	7.48
124 W	AIR	13.76	13.26	13.35	13.55	14.76	15.93	16.50	17.57	18.06	16.69	16.06	14.94
	SEA	14.50	13.74	13.79	14.00	14.29	15.42	16.25	17.42	18.00	17.22	16.42	15.29
	VPA	12.93	12.49	12.32	12.47	13.66	14.94	16.27	16.97	17.22	15.86	14.93	14.10
	VPS	16.62	15.77	15.84	16.06	16.38	17.63	18.53	20.05	20.77	19.73	18.75	17.47
	CLD	59.11	65.92	61.18	62.82	67.07	62.88	72.52	68.90	58.04	58.15	51.13	57.11
34 N	SPD	6.77	7.26	7.78	8.25	8.14	8.11	8.38	8.46	7.04	6.98	6.30	7.31
125 W	AIR	13.69	13.39	13.67	13.78	14.77	15.65	16.71	17.82	18.10	17.13	16.21	14.84
	SEA	14.39	13.89	13.87	14.29	14.66	15.56	16.72	17.63	18.41	17.77	16.90	15.55
	VPA	13.04	12.47	12.52	12.45	13.66	15.10	16.12	17.16	17.36	16.16	15.06	13.73
	VPS	16.47	15.92	15.92	16.35	16.75	17.79	19.15	20.21	21.25	20.43	19.34	17.77
	CLD	65.14	64.01	60.52	65.10	72.96	66.03	72.60	69.94	55.65	61.25	59.49	56.19
34 N	SPD	7.24	7.59	7.33	8.07	7.81	8.28	7.85	7.26	6.41	6.86	6.41	7.22
126 W	AIR	14.14	13.38	13.45	14.16	15.29	15.76	16.64	18.20	18.74	17.45	16.51	15.18
	SEA	14.65	14.11	13.83	14.62	15.16	15.82	16.63	18.26	18.61	18.20	17.28	15.70
	VPA	13.31	12.56	12.15	12.21	13.77	14.74	16.34	17.45	17.98	16.37	14.85	14.21
	VPS	16.73	16.16	15.89	16.71	17.31	18.05	19.00	21.05	21.54	20.99	19.83	17.92
	CLD	64.07	68.70	64.92	63.99	70.32	72.08	81.58	62.70	69.60	62.25	65.37	64.91
34 N	SPD	7.62	6.93	6.89	7.93	8.25	7.89	7.78	7.22	6.65	6.16	7.33	6.98
127 W	AIR	14.44	13.85	13.82	14.19	15.48	16.39	17.25	18.16	18.72	17.79	16.55	15.44
	SEA	15.13	14.26	14.18	14.36	15.26	16.11	17.20	18.21	19.20	18.19	17.27	16.42
	VPA	13.60	13.15	12.31	12.96	14.11	15.64	16.62	17.32	17.84	16.40	15.46	14.33
	VPS	17.30	16.32	16.25	16.43	17.40	18.40	19.71	20.98	22.35	21.00	19.79	18.76
	CLD	69.62	63.51	67.65	69.82	74.07	74.74	73.21	73.97	60.26	63.03	66.66	63.39
34 N	SPD	7.27	7.29	7.43	8.03	7.47	7.30	7.12	7.44	6.83	6.68	7.50	6.87
128 W	AIR	14.49	13.84	14.05	13.94	14.90	16.15	17.69	19.06	18.85	18.31	16.87	15.41
	SEA	15.22	14.22	14.29	14.67	15.39	16.32	17.70	18.82	19.23	18.96	17.63	16.03
	VPA	13.70	12.67	12.35	12.54	13.85	15.05	16.65	18.52	17.64	16.91	15.53	14.11
	VPS	17.36	16.29	16.35	16.78	17.57	18.62	20.33	21.88	22.40	22.02	20.23	18.32
	CLD	68.61	70.68	66.31	65.31	72.32	77.06	80.90	70.58	63.39	61.73	60.23	67.53

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
35 N	SPD	6.10	6.55	7.57	7.79	8.00	7.51	6.71	7.11	6.18	6.01	5.66	6.19
121 W	AIR	12.75	12.66	12.68	12.65	13.16	14.21	14.60	15.48	16.15	16.25	14.97	13.99
	SEA	13.14	12.95	12.77	12.40	12.84	13.63	14.26	15.58	16.10	16.71	15.17	14.23
	VPA	11.69	11.56	11.73	12.02	12.66	13.64	14.58	15.37	15.65	15.29	13.94	11.96
	VPS	15.16	14.99	14.82	14.49	14.92	15.70	16.38	17.83	18.44	19.18	17.33	16.31
	CLD	40.34	46.70	46.36	47.80	54.37	59.37	68.56	66.37	55.54	47.47	41.12	44.27
35 N	SPD	7.08	6.75	7.69	8.02	7.92	7.61	8.00	7.78	7.12	6.71	6.50	5.82
122 W	AIR	13.01	12.38	12.59	12.93	13.49	14.34	14.99	15.90	16.67	16.03	15.00	13.91
	SEA	13.40	13.04	13.12	13.20	13.21	14.03	14.78	15.68	16.28	16.28	15.21	14.09
	VPA	12.36	11.46	11.82	12.09	12.88	13.93	14.89	15.72	16.11	15.48	14.32	12.77
	VPS	15.43	15.07	15.18	15.23	15.27	16.10	16.89	17.91	18.61	18.61	17.37	16.13
	CLD	56.79	48.76	50.06	55.41	61.17	64.81	75.68	63.66	55.43	52.69	51.74	46.46
35 N	SPD	7.30	8.12	7.53	8.26	8.53	8.37	8.24	8.16	6.52	6.29	6.64	7.74
123 W	AIR	12.99	12.55	12.95	13.19	13.61	14.78	15.55	16.73	16.71	16.35	15.25	13.76
	SEA	13.47	13.25	13.20	13.43	13.87	14.24	15.65	16.33	17.00	16.59	15.05	14.28
	VPA	12.43	12.19	11.96	11.92	12.83	14.32	15.17	16.41	16.25	15.73	14.31	12.74
	VPS	15.48	15.28	15.24	15.45	15.93	16.31	17.86	18.65	19.46	18.97	17.22	16.36
	CLD	67.15	60.67	56.25	56.25	67.22	65.64	67.70	69.05	64.01	51.76	54.03	56.54
35 N	SPD	7.15	7.41	7.51	7.79	7.17	8.43	7.57	7.17	7.03	6.01	6.93	7.61
124 W	AIR	13.01	12.97	12.99	13.41	13.83	15.04	16.20	17.06	17.02	17.14	15.34	13.68
	SEA	13.70	13.15	13.59	13.49	13.82	14.80	15.97	17.06	17.34	17.14	16.00	14.75
	VPA	12.57	12.32	12.12	12.45	12.85	14.57	15.86	16.75	16.33	16.50	14.56	12.73
	VPS	15.74	15.17	15.64	15.52	15.90	16.92	18.22	19.56	19.94	19.62	18.28	16.86
	CLD	65.55	65.68	57.32	58.82	61.78	61.21	74.91	67.60	63.42	52.97	55.72	51.76
35 N	SPD	7.04	7.65	7.48	8.38	7.74	7.83	8.44	7.94	7.53	6.46	6.63	8.15
125 W	AIR	13.07	12.60	13.13	13.20	14.15	15.09	16.37	17.52	18.16	17.02	16.07	14.48
	SEA	13.94	13.54	13.60	13.61	14.17	14.91	16.21	17.41	17.53	17.50	16.38	15.11
	VPA	12.70	12.21	12.14	11.91	13.20	14.32	15.79	17.19	16.81	16.14	15.00	13.49
	VPS	15.99	15.59	15.64	15.66	16.22	17.07	18.48	20.02	20.15	20.06	18.72	17.23
	CLD	67.99	65.26	58.76	60.52	71.42	72.93	75.64	65.35	56.89	65.05	62.00	67.50
35 N	SPD	7.82	6.93	7.39	9.27	8.07	8.65	8.70	7.20	6.83	6.42	7.67	7.31
126 W	AIR	13.86	13.26	12.83	13.27	14.18	15.73	16.23	17.92	17.89	17.26	15.83	14.40
	SEA	14.20	13.67	13.85	14.02	14.35	15.38	16.24	17.94	17.99	17.87	16.43	15.52
	VPA	13.41	12.65	11.96	11.61	13.07	14.82	15.59	17.44	16.70	16.16	14.61	13.26
	VPS	16.28	15.71	15.91	16.06	16.40	17.56	18.53	20.68	20.75	20.55	18.77	17.68
	CLD	67.80	73.61	58.37	62.95	72.25	68.15	80.90	68.56	65.52	61.74	62.77	64.85
35 N	SPD	7.46	7.95	7.94	8.45	8.34	8.02	7.68	7.94	6.67	7.12	7.95	8.25
127 W	AIR	13.85	13.32	13.32	13.38	14.38	15.69	16.82	18.21	18.45	17.55	16.07	14.58
	SEA	14.57	14.09	13.75	13.86	14.53	15.75	16.95	18.13	18.66	18.21	17.00	15.54
	VPA	13.05	12.58	12.44	12.14	13.28	15.00	15.96	17.22	17.24	16.29	14.53	13.29
	VPS	16.67	16.15	15.80	15.90	16.60	18.01	19.39	20.92	21.61	21.02	19.45	17.73
	CLD	72.59	69.25	69.61	66.37	69.58	73.50	79.53	64.54	64.55	66.42	67.91	70.11
35 N	SPD	7.51	8.12	7.86	7.87	7.47	7.92	7.94	7.32	7.14	6.69	6.51	7.35
128 W	AIR	13.98	13.43	13.63	13.55	14.68	16.19	17.20	18.41	18.61	17.81	16.33	14.96
	SEA	14.85	14.24	14.01	13.87	14.70	16.11	17.14	18.14	18.97	18.03	17.35	16.04
	VPA	12.95	12.57	12.27	11.99	13.34	15.07	16.07	17.55	17.20	16.76	15.04	13.67
	VPS	16.97	16.32	16.06	15.90	16.80	18.38	19.62	20.91	22.02	20.75	19.88	18.31
	CLD	71.08	72.05	69.97	70.35	70.38	76.53	80.09	73.97	67.47	64.54	64.97	67.37
35 N	SPD	7.73	7.89	7.77	7.88	7.15	7.60	7.56	6.65	7.25	7.13	6.87	7.23
129 W	AIR	14.07	13.58	13.36	13.80	14.58	16.30	17.51	18.63	19.08	18.17	16.64	15.28
	SEA	15.08	14.58	14.19	14.26	14.94	16.52	17.64	18.62	19.42	18.69	17.50	16.32
	VPA	13.03	12.55	12.25	12.26	13.31	15.04	16.22	17.74	17.72	16.72	15.20	14.05
	VPS	17.21	16.68	16.25	16.32	17.06	18.89	20.26	21.56	22.66	21.63	20.08	18.62
	CLD	71.76	69.87	69.62	71.91	75.77	74.39	81.43	72.44	67.45	65.46	63.12	71.02
35 N	SPD	8.00	7.74	7.83	7.36	6.91	6.98	7.27	6.12	7.02	6.82	7.30	7.38
130 W	AIR	13.96	13.66	13.47	13.69	14.88	16.50	17.68	19.37	19.21	18.24	16.88	15.42
	SEA	15.35	14.62	14.41	14.48	15.24	16.75	18.08	19.37	19.65	18.96	17.86	16.60
	VPA	12.90	12.53	12.35	11.99	13.51	15.56	16.48	18.29	17.61	16.67	15.29	14.18
	VPS	17.51	16.72	16.48	16.55	17.38	19.16	20.81	22.57	22.98	21.99	20.53	18.96
	CLD	73.61	70.74	71.52	70.35	72.72	74.02	79.09	70.01	66.56	67.00	65.13	70.08

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
36 N	SPD	6.50	7.26	7.06	8.05	8.70	8.66	7.37	7.55	7.04	6.84	5.95	6.71
122 W	AIR	12.32	12.26	12.39	12.35	12.72	14.00	15.06	15.25	15.96	15.55	14.51	13.18
	SEA	12.80	12.68	12.46	12.30	12.49	13.17	14.46	14.75	15.91	15.40	14.61	13.75
	VPA	11.41	11.46	11.46	11.73	12.29	13.50	14.72	15.06	15.31	14.80	13.33	12.05
	VPS	14.82	14.71	14.52	14.38	14.56	15.28	16.61	16.89	18.20	17.62	16.72	15.79
	CLD	51.49	47.69	46.27	49.50	51.97	60.27	65.46	57.31	52.06	43.89	43.01	43.11
36 N	SPD	7.29	8.02	7.97	8.82	8.36	8.43	8.55	8.38	7.40	7.84	7.04	7.62
123 W	AIR	12.24	12.33	12.31	12.42	13.25	14.21	15.25	15.99	16.67	15.44	14.54	13.16
	SEA	12.98	12.77	12.77	12.34	13.41	14.26	15.20	15.97	16.54	15.68	14.99	13.96
	VPA	11.24	11.46	11.15	11.79	12.65	13.76	14.83	15.81	15.82	14.62	14.01	11.73
	VPS	15.00	14.79	14.82	14.41	15.46	16.36	17.36	18.25	18.90	17.90	17.11	16.01
	CLD	50.58	62.15	50.78	53.99	61.79	67.39	65.86	59.24	49.31	49.60	50.77	49.12
36 N	SPD	7.53	6.57	6.99	8.06	7.97	9.01	8.22	7.81	7.19	7.04	6.05	6.45
124 W	AIR	12.32	12.09	12.47	12.64	13.76	14.53	15.58	16.61	17.10	15.93	14.79	13.64
	SEA	13.18	13.12	12.64	12.98	13.43	13.90	15.31	16.52	16.69	16.61	15.21	14.36
	VPA	12.21	11.66	11.88	11.84	12.89	14.03	15.12	16.42	16.86	15.37	13.99	12.88
	VPS	15.23	15.15	14.67	15.01	15.46	15.97	17.47	18.87	19.13	19.01	17.36	16.41
	CLD	60.25	66.66	60.85	56.05	61.21	62.07	67.91	62.73	56.00	56.30	56.36	58.01
36 N	SPD	8.03	7.45	7.89	9.02	8.79	8.88	8.88	8.25	6.67	7.48	7.19	7.29
125 W	AIR	12.51	12.40	12.41	12.75	13.71	14.53	15.64	16.85	17.16	16.52	14.92	13.30
	SEA	13.33	13.21	12.79	13.13	13.68	14.17	15.56	16.71	17.24	16.97	15.68	14.39
	VPA	12.33	12.08	11.70	11.63	12.88	13.91	15.24	16.59	16.70	15.61	14.03	12.56
	VPS	15.36	15.25	14.82	15.18	15.73	16.23	17.76	19.10	19.79	19.41	17.90	16.46
	CLD	66.79	63.01	63.80	55.75	64.25	64.67	71.65	62.12	58.67	55.94	59.79	55.42
36 N	SPD	7.92	7.89	8.01	8.84	7.87	8.90	8.58	7.62	7.18	7.84	7.16	7.80
126 W	AIR	12.92	12.35	12.36	12.35	13.56	14.97	16.11	17.14	17.67	16.78	15.31	13.80
	SEA	13.48	13.10	13.05	12.99	13.75	14.89	15.96	16.88	17.98	17.16	15.97	14.83
	VPA	12.27	11.84	11.64	11.46	12.79	14.26	15.59	16.73	16.93	15.79	14.29	12.91
	VPS	15.52	15.15	15.09	15.02	15.80	17.02	18.23	19.32	20.72	19.67	18.25	16.96
	CLD	65.32	67.18	68.28	64.60	66.86	64.91	71.53	64.07	61.03	55.21	62.20	62.31
36 N	SPD	7.61	7.71	8.06	7.93	7.93	8.46	8.48	7.54	7.33	7.48	7.30	7.35
127 W	AIR	13.08	12.66	12.78	12.86	13.75	15.16	16.27	17.66	18.11	17.02	15.79	14.28
	SEA	13.52	13.15	13.16	13.35	14.04	15.20	16.15	17.47	18.13	17.48	16.44	15.13
	VPA	12.23	12.13	11.66	11.69	12.76	14.47	15.74	17.03	17.12	15.90	14.59	13.37
	VPS	15.59	15.19	15.19	15.37	16.11	17.35	18.44	20.07	20.92	20.06	18.81	17.28
	CLD	69.15	67.26	66.73	66.22	71.11	70.95	76.15	63.17	58.45	63.11	63.03	67.38
36 N	SPD	7.21	7.72	7.64	7.82	7.42	8.26	8.15	7.20	7.14	7.07	7.16	7.45
128 W	AIR	13.74	12.88	13.02	13.51	14.49	16.08	17.00	18.24	18.40	17.62	16.34	14.83
	SEA	14.74	13.78	13.61	13.59	14.44	16.11	17.14	18.10	18.57	17.80	17.20	15.77
	VPA	12.87	11.94	11.76	12.11	13.24	14.96	16.09	17.29	17.20	16.18	15.01	13.60
	VPS	16.87	15.83	15.65	15.62	16.50	18.39	19.62	20.85	21.46	20.46	19.71	18.00
	CLD	69.38	69.44	68.31	66.03	70.05	67.38	77.43	71.18	63.53	63.64	64.17	68.65
36 N	SPD	7.69	7.74	7.94	7.60	7.45	7.46	7.42	6.72	6.94	6.85	7.33	7.57
129 W	AIR	13.55	13.04	13.00	13.33	14.20	16.08	17.15	18.57	18.91	17.76	16.25	14.66
	SEA	14.59	13.87	13.65	13.85	14.49	16.24	17.32	18.50	19.29	18.25	17.15	15.78
	VPA	12.57	12.24	11.75	12.02	12.93	15.08	16.25	17.70	17.61	16.52	14.93	13.60
	VPS	16.69	15.93	15.68	15.88	16.57	18.55	19.84	21.38	22.45	21.05	19.65	18.01
	CLD	72.45	68.65	69.67	69.88	71.98	75.72	81.13	71.40	64.54	67.19	67.30	71.57
36 N	SPD	8.01	7.55	7.71	7.85	6.98	7.20	7.23	6.18	7.45	6.46	7.22	7.96
130 W	AIR	13.68	13.13	13.10	13.24	14.50	16.12	17.47	19.12	18.95	17.95	16.53	15.12
	SEA	14.65	13.99	13.85	13.96	14.70	16.18	17.68	19.27	19.43	18.53	17.37	16.15
	VPA	12.91	12.39	12.10	11.95	13.20	14.98	16.51	18.31	17.58	16.36	15.21	14.14
	VPS	16.76	16.04	15.89	15.99	16.79	18.47	20.31	22.47	22.66	21.42	19.95	18.42
	CLD	73.28	70.27	75.18	71.12	70.67	75.98	80.57	69.05	68.86	67.65	71.19	72.80
36 N	SPD	8.39	7.44	8.02	7.65	7.17	6.78	6.37	6.24	6.99	6.47	8.25	8.44
131 W	AIR	13.61	13.62	13.51	13.19	14.55	16.26	18.07	19.30	19.45	18.39	16.81	14.99
	SEA	14.91	14.14	14.16	14.11	14.97	16.39	18.05	19.82	19.63	19.02	17.75	16.04
	VPA	12.56	12.49	12.12	11.74	13.30	15.45	17.10	18.14	18.10	17.05	14.99	13.63
	VPS	17.04	16.19	16.20	16.17	17.12	18.72	20.78	23.24	22.94	22.08	20.39	18.30
	CLD	72.10	72.10	73.83	69.68	73.67	78.22	74.39	72.05	67.53	62.42	70.74	76.75

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
37 N	SPD	6.02	6.87	6.47	7.28	7.76	7.01	6.21	5.85	5.68	6.05	6.30	6.64
122 W	AIR	11.79	12.19	12.39	12.32	12.71	13.54	14.25	14.48	15.79	15.22	14.13	12.47
	SEA	12.70	12.66	12.26	11.83	12.39	13.08	13.75	14.41	15.37	14.88	14.18	13.08
	VPA	11.21	11.58	11.68	11.57	12.43	13.27	14.03	14.39	15.13	14.30	13.00	11.21
	VPS	14.74	14.71	14.34	13.93	14.47	15.16	15.84	16.52	17.62	17.02	16.25	15.12
	CLD	53.10	50.38	45.71	46.23	61.58	62.11	57.48	62.13	44.47	46.92	53.97	38.87
37 N	SPD	7.58	8.01	7.87	8.32	8.86	8.00	7.62	7.86	6.89	7.02	6.90	6.79
123 W	AIR	11.51	11.74	11.87	11.95	12.67	13.74	14.35	15.01	15.70	15.11	14.08	12.67
	SEA	12.41	12.31	12.26	12.11	12.55	13.43	14.48	14.86	15.65	15.20	14.19	13.20
	VPA	10.89	10.98	11.09	11.46	12.26	13.55	14.22	14.91	15.18	14.25	13.27	11.54
	VPS	14.46	14.37	14.34	14.21	14.62	15.50	16.60	17.01	17.92	17.38	16.27	15.26
	CLD	55.78	53.69	53.24	52.67	54.66	57.93	63.59	58.36	52.05	43.68	51.25	48.59
37 N	SPD	7.93	8.11	8.05	9.23	9.00	8.79	8.75	8.78	7.31	7.51	7.06	7.50
124 W	AIR	11.86	11.66	11.63	11.90	12.53	13.99	14.77	15.53	16.17	15.11	14.02	12.87
	SEA	12.58	12.23	12.23	12.29	12.59	13.65	14.62	15.19	16.09	15.34	14.49	13.55
	VPA	11.41	11.42	11.03	11.21	12.17	13.66	14.72	15.55	15.94	14.64	13.53	12.20
	VPS	14.63	14.31	14.32	14.38	14.67	15.74	16.74	17.38	18.46	17.55	16.59	15.61
	CLD	62.57	59.18	57.65	54.01	55.60	58.14	60.96	48.63	45.07	46.26	53.86	57.19
37 N	SPD	7.39	7.82	8.09	8.99	9.08	9.41	8.73	8.24	7.53	7.47	7.03	7.56
125 W	AIR	11.97	11.75	11.88	12.10	12.88	14.31	15.24	16.33	16.70	15.62	14.41	12.91
	SEA	12.65	12.52	12.52	12.55	12.97	14.05	14.76	15.98	16.59	16.02	14.96	13.70
	VPA	11.57	11.44	11.24	11.42	12.26	13.96	14.93	16.23	16.26	15.09	13.81	12.36
	VPS	14.71	14.58	14.58	14.62	15.01	16.15	16.89	18.28	19.00	18.31	17.11	15.76
	CLD	61.53	62.25	61.09	57.91	63.97	56.93	65.96	57.49	50.58	48.81	55.98	62.52
37 N	SPD	7.92	7.86	7.94	8.73	8.75	8.81	8.77	7.80	7.40	7.45	7.24	7.18
126 W	AIR	12.36	11.89	11.83	12.15	13.22	14.67	15.74	17.02	17.20	16.30	14.83	13.35
	SEA	13.16	12.67	12.51	12.74	13.26	14.25	15.50	16.72	17.03	16.59	15.57	14.26
	VPA	12.01	11.46	11.08	11.25	12.62	14.01	15.44	16.69	16.68	15.37	14.00	12.75
	VPS	15.20	14.72	14.59	14.80	15.30	16.32	17.72	19.15	19.56	19.01	17.81	16.34
	CLD	65.68	66.14	62.25	63.72	64.76	66.49	68.93	62.46	50.97	53.69	62.13	63.94
37 N	SPD	7.59	8.28	8.47	8.44	8.30	8.67	8.07	7.87	7.37	7.11	7.19	7.54
127 W	AIR	12.67	12.19	12.25	12.44	13.51	15.01	16.05	17.36	17.75	16.58	15.52	13.54
	SEA	13.33	12.77	12.80	12.83	13.62	14.56	15.75	17.03	17.50	16.70	15.69	14.24
	VPA	12.06	11.47	11.40	11.51	12.50	14.25	15.59	16.98	17.06	15.70	14.74	12.81
	VPS	15.36	14.81	14.84	14.87	15.65	16.66	17.09	19.53	20.13	19.12	17.94	16.32
	CLD	67.05	66.71	68.18	66.92	70.22	70.51	75.46	65.76	53.79	64.16	61.90	70.13
37 N	SPD	8.31	8.15	8.12	8.35	7.69	8.38	8.18	7.47	7.69	7.05	7.25	7.81
128 W	AIR	13.06	12.45	12.44	12.61	13.85	15.25	16.74	18.29	18.17	17.10	15.79	13.87
	SEA	13.75	13.11	12.85	13.05	13.79	14.87	16.23	17.55	17.94	17.22	16.50	14.91
	VPA	12.54	11.63	11.46	11.43	12.78	14.54	15.85	17.55	17.26	15.71	14.79	12.92
	VPS	15.82	15.15	14.91	15.07	15.82	16.99	18.52	20.17	20.69	19.77	18.88	17.04
	CLD	68.28	72.36	71.29	71.79	68.51	74.63	74.80	63.35	62.09	56.64	64.75	69.73
37 N	SPD	7.54	8.38	8.01	7.71	8.11	7.57	7.84	6.88	7.13	6.84	7.56	8.21
129 W	AIR	12.90	12.24	12.36	12.64	13.67	15.58	17.09	18.73	18.54	17.40	16.10	14.28
	SEA	14.18	13.32	13.08	13.36	13.99	15.51	16.86	18.56	18.42	17.61	16.76	15.29
	VPA	12.02	11.75	11.60	11.50	12.57	14.65	16.28	17.92	17.34	15.87	14.85	13.15
	VPS	16.30	15.39	15.11	15.38	16.04	17.70	19.28	21.49	21.31	20.23	19.17	17.47
	CLD	69.68	73.45	71.23	70.15	73.87	72.80	81.07	68.01	62.77	61.90	70.81	74.18
37 N	SPD	8.25	8.03	8.13	7.73	7.27	7.27	7.19	6.75	7.44	6.81	7.34	8.43
130 W	AIR	13.52	12.77	12.50	13.04	14.05	15.95	17.36	18.92	18.70	17.88	16.07	14.51
	SEA	14.40	13.65	13.35	13.48	14.21	15.64	17.25	18.55	19.26	18.43	17.18	15.49
	VPA	12.80	12.00	11.53	11.78	12.64	14.93	16.55	17.75	17.60	16.23	14.70	13.34
	VPS	16.47	15.70	15.37	15.50	16.26	17.85	19.76	21.47	22.44	21.28	19.67	17.67
	CLD	74.66	72.90	74.43	72.28	77.31	75.52	74.66	68.37	62.93	62.04	72.36	71.52
37 N	SPD	8.58	7.96	8.60	7.34	6.67	7.22	7.10	6.03	6.40	7.03	7.94	7.78
131 W	AIR	13.27	12.51	12.68	12.92	13.92	15.76	17.47	19.05	19.01	17.66	16.40	14.54
	SEA	14.59	13.84	13.46	13.67	14.17	15.80	17.57	19.08	19.36	18.56	17.41	15.81
	VPA	12.51	11.63	11.64	11.82	12.65	14.68	16.62	17.85	18.00	16.03	15.05	13.32
	VPS	16.68	15.90	15.49	15.70	16.21	18.03	20.19	22.19	22.57	21.46	19.96	18.04
	CLD	74.01	71.75	73.55	68.11	77.58	73.85	79.94	68.39	66.22	66.68	72.17	71.37

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
38 N	SPD	7.38	6.71	7.46	8.52	7.88	7.85	6.27	6.69	5.46	5.80	5.69	6.98
123 W	AIR	11.56	11.82	11.91	11.45	12.47	13.45	14.06	14.48	14.98	14.37	13.59	11.81
	SEA	12.04	11.92	11.86	11.61	12.46	12.82	13.53	14.10	14.33	14.35	13.78	12.59
	VPA	11.44	11.68	11.31	11.08	12.07	13.22	14.00	14.19	14.31	13.63	12.99	11.30
	VPS	14.11	14.01	13.96	13.77	14.68	14.95	15.65	16.26	16.47	16.45	15.81	14.64
	CLD	53.02	53.43	48.47	41.18	46.79	52.93	60.99	53.93	40.12	47.28	58.09	58.18
38 N	SPD	7.18	8.48	7.88	8.94	9.26	8.93	8.93	8.53	7.15	6.54	7.37	8.26
124 W	AIR	11.48	11.22	11.40	11.45	12.33	13.45	14.06	14.72	15.33	14.87	13.96	12.47
	SEA	12.12	12.12	11.72	11.75	12.11	12.83	13.40	14.26	14.88	14.85	14.29	13.40
	VPA	10.89	10.98	10.78	10.87	12.13	13.21	14.00	14.82	15.15	14.43	13.56	11.85
	VPS	14.21	14.20	13.84	13.86	14.22	14.94	15.49	16.40	17.05	17.01	16.39	15.44
	CLD	53.38	52.54	54.20	47.88	51.89	55.03	56.09	60.06	53.94	46.63	54.18	58.37
38 N	SPD	7.03	8.69	8.77	8.36	8.76	9.58	9.88	8.80	7.25	7.27	6.49	7.60
125 W	AIR	11.95	11.14	11.27	11.71	12.77	13.99	15.04	15.78	15.98	15.25	14.19	12.72
	SEA	12.87	12.25	11.82	12.15	12.73	13.74	14.60	15.13	15.76	15.52	15.08	13.46
	VPA	11.50	11.21	10.80	11.34	12.16	13.49	14.68	15.74	15.92	14.73	13.87	12.12
	VPS	14.91	14.35	13.96	14.23	14.82	15.87	16.74	17.33	18.05	17.74	17.24	15.50
	CLD	60.78	62.40	62.17	60.67	61.56	58.14	57.11	54.09	48.52	48.03	58.13	64.79
38 N	SPD	7.69	8.58	7.46	8.84	8.58	9.23	9.25	8.56	7.74	7.35	7.57	8.38
126 W	AIR	11.39	10.98	11.73	11.85	12.76	14.25	15.41	16.52	16.91	15.95	14.67	12.87
	SEA	12.86	12.11	12.36	12.41	12.87	14.06	15.12	15.80	16.49	16.36	15.35	14.00
	VPA	11.09	11.11	11.13	10.94	12.24	13.88	14.99	16.19	16.35	15.31	13.98	12.26
	VPS	14.89	14.19	14.40	14.46	14.91	16.15	17.29	18.08	18.90	18.71	17.52	16.08
	CLD	67.89	62.04	64.27	64.20	68.62	67.70	66.44	60.85	53.71	52.99	56.01	70.12
38 N	SPD	8.12	8.46	8.17	8.17	7.88	9.38	8.66	8.35	7.52	7.77	7.12	8.17
127 W	AIR	12.16	11.61	11.69	11.76	13.17	14.79	15.95	17.26	17.59	16.49	15.36	13.43
	SEA	13.24	12.35	12.23	12.71	13.16	14.60	15.78	16.68	17.17	16.77	15.72	14.53
	VPA	11.74	11.25	11.08	11.18	12.00	14.04	15.37	16.64	16.91	15.29	14.43	12.62
	VPS	15.28	14.42	14.27	14.77	15.19	16.73	18.04	19.12	19.70	19.17	17.94	16.61
	CLD	70.69	72.72	68.21	68.88	68.01	68.41	72.69	67.42	51.13	59.16	66.51	69.84
38 N	SPD	8.98	8.38	8.44	7.49	7.39	8.26	8.25	7.31	7.44	7.65	7.37	8.58
128 W	AIR	11.91	12.11	11.73	12.42	13.48	15.06	16.40	17.87	18.20	16.86	15.45	13.41
	SEA	13.44	12.87	12.58	12.58	13.53	14.72	16.25	17.44	17.70	17.43	16.22	14.81
	VPA	11.28	11.50	10.73	11.35	12.28	14.44	15.57	17.29	17.11	15.73	14.43	12.72
	VPS	15.46	14.92	14.63	14.61	15.58	16.83	18.58	20.05	20.36	19.98	18.52	16.93
	CLD	69.64	68.68	59.27	62.23	69.86	75.36	78.63	66.74	56.54	59.54	62.32	72.39
38 N	SPD	9.31	7.98	8.33	8.10	7.49	7.90	8.27	7.58	7.27	7.41	7.59	8.22
129 W	AIR	12.33	12.13	11.95	12.11	13.48	15.61	16.79	17.95	18.57	17.26	15.66	14.05
	SEA	13.84	13.00	12.70	13.08	13.50	15.43	16.55	17.96	18.57	17.90	16.49	15.38
	VPA	12.00	11.34	11.02	11.06	12.67	14.64	16.09	17.00	17.37	15.97	14.52	13.02
	VPS	15.91	15.04	14.74	15.11	15.53	17.62	18.91	20.71	21.51	20.59	18.84	17.54
	CLD	77.36	70.13	71.48	73.77	69.18	70.42	74.14	69.10	59.00	63.52	65.93	74.46
38 N	SPD	8.69	8.57	8.29	7.62	7.20	7.57	7.54	7.05	6.97	7.11	8.39	8.75
130 W	AIR	12.51	12.15	11.71	12.45	13.60	15.22	16.84	18.39	18.79	17.57	15.64	13.92
	SEA	13.88	13.27	12.85	12.95	13.54	15.23	17.13	18.39	18.87	18.20	16.82	15.31
	VPA	11.95	11.31	11.15	11.16	12.31	14.29	15.78	17.53	17.34	15.97	14.43	13.14
	VPS	15.93	15.32	14.90	14.97	15.59	17.39	19.63	21.26	21.86	20.97	19.21	17.47
	CLD	70.83	68.57	68.98	73.00	71.46	73.07	79.70	70.07	63.58	62.50	74.31	75.10
38 N	SPD	8.25	8.52	8.18	7.95	6.76	7.55	7.33	6.11	7.21	7.35	7.32	8.14
131 W	AIR	13.05	12.45	12.14	12.73	14.04	15.71	17.31	19.03	18.79	17.79	16.09	14.34
	SEA	13.91	13.28	12.91	13.20	14.41	15.73	17.33	18.81	19.29	18.42	16.92	15.59
	VPA	11.89	11.52	11.37	11.17	12.96	14.68	16.37	17.93	17.55	16.27	14.79	13.60
	VPS	15.94	15.30	14.93	15.24	16.48	17.94	19.86	21.84	22.47	21.25	19.37	17.77
	CLD	73.25	73.67	73.21	71.21	78.58	68.09	82.91	66.90	66.49	62.08	67.06	74.47
38 N	SPD	8.89	8.30	8.31	7.74	6.91	6.97	6.58	6.83	6.42	7.48	8.10	9.12
132 W	AIR	12.59	12.67	12.10	12.36	13.68	15.63	17.41	18.86	19.02	17.96	15.93	14.61
	SEA	13.90	13.60	13.24	13.16	13.99	15.83	17.65	19.32	19.57	18.71	17.04	15.74
	VPA	12.16	11.79	11.38	11.21	12.30	14.77	16.77	17.81	17.55	16.24	14.49	13.41
	VPS	15.98	15.66	15.28	15.20	16.04	18.08	20.26	22.52	22.84	21.63	19.49	17.95
	CLD	79.28	76.12	74.21	72.72	75.53	75.49	79.24	68.59	63.61	68.29	74.39	70.66

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
39 N 124 W	SPD	7.64	7.79	7.59	7.51	9.11	8.80	8.99	8.63	6.29	6.79	6.28	6.93
	AIR	10.76	11.08	10.91	10.88	11.83	13.32	13.45	14.43	14.46	13.94	13.40	11.55
	SEA	11.46	11.38	11.03	10.70	11.23	12.11	12.42	13.06	13.55	13.66	13.58	12.39
	VPA	10.50	10.90	10.58	10.67	11.52	13.04	13.51	14.39	14.26	13.42	12.98	11.15
	VPS	13.58	13.51	13.21	12.97	13.39	14.24	14.55	15.17	15.68	15.75	15.62	14.47
	CLD	58.64	56.07	51.83	45.42	47.23	48.09	46.63	42.40	42.19	41.24	51.28	53.48
39 N 125 W	SPD	7.98	7.63	8.79	9.07	9.02	9.40	9.65	9.12	8.31	7.60	7.37	7.72
	AIR	11.53	11.18	11.27	11.51	12.34	14.06	14.89	15.84	15.78	15.22	14.10	12.21
	SEA	11.89	11.80	11.50	11.57	12.29	13.51	14.52	14.81	15.53	15.56	14.56	13.29
	VPA	11.36	10.92	10.61	11.02	12.29	13.37	14.65	15.49	15.26	14.43	13.58	11.82
	VPS	13.97	13.89	13.61	13.67	14.37	15.60	16.66	17.02	17.80	17.79	16.74	15.32
	CLD	60.73	61.96	58.89	59.00	60.38	55.57	62.07	51.71	47.08	46.12	62.20	60.80
39 N 126 W	SPD	8.77	7.60	8.19	8.08	8.22	9.07	9.36	8.63	7.96	6.81	7.31	7.76
	AIR	11.60	11.29	10.95	11.48	12.87	14.47	15.62	16.59	17.17	15.77	14.25	12.53
	SEA	12.61	11.98	11.78	12.05	12.90	14.19	15.16	15.97	17.13	16.18	15.34	13.64
	VPA	11.43	11.55	10.51	10.83	12.29	13.71	15.12	16.38	16.32	14.81	13.43	12.00
	VPS	14.65	14.07	13.88	14.10	14.94	16.25	17.35	18.27	19.66	18.49	17.57	15.71
	CLD	66.76	64.66	61.85	57.55	63.38	65.42	66.11	63.75	45.09	51.23	60.52	60.36
39 N 127 W	SPD	8.85	7.34	8.27	8.16	8.95	8.98	9.26	7.95	7.99	7.15	8.04	8.46
	AIR	11.42	10.84	10.97	11.73	12.46	14.11	16.06	17.31	17.37	16.54	14.80	12.28
	SEA	12.60	11.67	11.72	12.07	13.10	14.16	15.55	17.03	17.14	17.03	15.85	13.81
	VPA	11.52	10.77	10.68	10.85	11.71	13.64	15.41	16.75	16.29	15.65	13.88	12.02
	VPS	14.68	13.79	13.80	14.12	15.12	16.22	17.75	19.53	19.65	19.49	13.08	15.84
	CLD	75.20	65.90	65.88	64.28	71.30	72.22	68.75	58.04	55.86	54.57	64.51	65.62
39 N 128 W	SPD	8.23	8.56	8.21	8.49	8.24	8.34	7.97	8.10	7.83	7.09	8.51	8.17
	AIR	12.43	11.61	11.38	11.53	13.11	14.90	16.58	17.79	17.83	16.64	15.20	12.66
	SEA	13.22	11.96	11.75	12.06	13.16	14.87	16.34	17.84	17.66	17.07	16.27	14.52
	VPA	11.84	11.36	10.66	10.87	12.30	14.16	15.67	17.01	16.92	15.56	14.51	12.05
	VPS	15.26	14.03	13.83	14.13	15.21	16.99	18.65	20.55	20.28	19.54	18.58	16.60
	CLD	77.20	71.54	67.37	71.71	73.02	69.35	68.21	67.27	61.79	61.57	68.82	67.65
39 N 129 W	SPD	8.17	8.25	8.26	8.01	7.05	7.60	7.87	7.61	7.75	6.64	8.33	8.03
	AIR	12.66	11.91	11.39	12.28	13.01	14.70	16.68	18.08	18.10	16.68	15.36	12.99
	SEA	13.63	12.62	11.93	12.55	13.59	14.90	16.70	17.91	18.30	17.80	16.18	14.44
	VPA	12.32	11.68	10.86	11.48	11.98	14.07	15.90	16.89	17.36	15.29	14.35	12.18
	VPS	15.67	14.66	14.00	14.60	15.63	17.01	19.11	20.63	21.14	20.43	18.45	16.50
	CLD	80.30	68.39	69.30	72.82	76.93	69.58	75.80	72.01	61.58	61.96	74.22	71.84
39 N 130 W	SPD	8.62	8.69	7.81	7.17	6.84	6.60	7.72	6.73	7.36	7.65	8.18	8.10
	AIR	12.80	12.63	11.57	11.67	13.09	14.84	16.62	18.53	18.29	17.13	15.63	13.31
	SEA	13.65	12.16	11.95	12.34	13.04	14.91	16.73	18.68	18.51	17.67	16.54	14.01
	VPA	12.30	11.81	11.03	11.00	11.72	14.07	15.71	17.44	17.14	15.72	13.98	12.94
	VPS	15.66	14.21	14.02	14.38	15.06	17.02	19.11	21.64	21.39	20.27	18.89	16.06
	CLD	76.54	69.08	65.12	75.00	74.72	73.74	78.56	71.39	64.34	61.44	68.23	72.45
39 N 131 W	SPD	9.50	8.14	8.16	7.24	6.85	6.79	6.86	6.23	6.86	7.26	8.42	8.31
	AIR	12.13	11.37	11.37	12.18	13.80	15.22	17.19	18.84	18.95	17.07	15.67	13.23
	SEA	13.23	12.44	12.14	12.59	13.90	15.05	17.20	18.85	19.00	17.97	16.19	14.83
	VPA	11.35	11.09	10.62	11.24	12.66	14.21	16.42	17.94	17.75	15.80	14.54	12.57
	VPS	15.26	14.48	14.18	14.64	15.94	17.17	19.68	21.87	22.07	20.66	18.48	16.90
	CLD	75.41	68.00	72.12	69.09	74.76	75.68	80.64	61.44	64.54	63.17	72.82	72.76
39 N 132 W	SPD	9.24	8.17	8.86	7.26	7.23	7.06	6.76	6.41	7.49	6.98	8.75	9.74
	AIR	11.83	12.01	11.55	11.85	13.13	15.24	16.85	18.86	18.54	17.25	15.31	13.70
	SEA	13.58	12.60	12.49	12.60	13.46	15.32	17.33	19.27	18.91	18.00	16.39	14.86
	VPA	11.49	11.05	10.91	10.77	12.06	14.47	16.02	18.09	17.54	15.86	14.13	12.77
	VPS	15.67	14.64	14.54	14.65	15.50	17.47	19.87	22.45	21.95	20.71	18.70	16.96
	CLD	76.89	75.46	66.92	72.09	71.63	73.74	73.86	71.74	72.95	66.29	70.17	76.82
39 N 133 W	SPD	9.55	7.81	8.35	8.16	6.81	6.13	6.35	6.04	7.13	7.15	8.57	8.24
	AIR	12.68	11.86	11.83	11.88	13.33	15.51	17.17	18.83	18.80	17.78	15.72	14.05
	SEA	13.72	12.84	12.62	12.68	13.69	15.65	17.67	19.29	19.55	18.75	16.80	15.26
	VPA	12.09	11.44	10.91	10.99	12.23	14.21	16.32	17.55	17.44	16.21	14.58	13.38
	VPS	15.77	14.88	14.66	14.73	15.71	17.83	20.28	22.45	22.80	21.70	19.17	17.39
	CLD	79.56	76.95	68.55	72.70	80.96	80.62	83.91	74.79	68.62	65.98	74.81	75.13

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
40 N 124 W	SPD	9.32	7.14	7.96	8.31	9.76	8.67	9.92	8.40	7.35	7.11	7.31	7.07
	AIR	10.28	11.46	11.16	10.91	11.82	12.58	13.06	13.35	13.92	12.97	13.02	10.85
	SEA	11.19	10.94	10.37	9.89	10.08	10.81	11.01	11.32	11.51	11.53	12.85	12.08
	VPA	10.93	11.98	11.04	10.84	12.10	12.65	13.40	13.77	13.72	13.05	13.10	10.79
	VPS	13.33	13.12	12.63	12.21	12.38	13.01	13.19	13.48	13.66	13.69	14.88	14.12
	CLD	55.77	55.41	50.51	52.32	49.62	55.01	50.14	51.95	29.98	45.99	64.42	57.10
40 N 125 W	SPD	8.68	8.32	7.57	8.77	8.93	8.62	9.43	9.23	8.08	7.26	7.88	8.53
	AIR	10.35	10.59	10.79	10.95	12.14	13.66	14.66	15.33	15.01	13.77	12.88	10.79
	SEA	11.29	11.09	11.05	11.17	11.55	12.65	13.19	14.30	14.40	13.54	13.43	11.93
	VPA	10.11	10.58	10.38	10.54	11.82	13.18	14.22	15.15	14.67	13.34	12.71	10.67
	VPS	13.43	13.25	13.21	13.31	13.68	14.74	15.30	16.48	16.60	15.62	15.48	14.05
	CLD	65.71	65.56	60.65	55.23	58.71	61.05	54.78	48.75	47.45	52.29	59.01	61.82
40 N 126 W	SPD	10.17	7.85	8.90	7.54	9.33	10.24	8.52	7.29	7.18	7.91	9.16	9.08
	AIR	10.97	10.83	11.24	11.06	12.18	14.37	15.62	16.88	16.57	15.46	13.21	12.00
	SEA	12.11	11.60	11.24	11.31	12.09	13.69	14.76	15.96	16.63	15.41	13.91	13.04
	VPA	10.80	11.02	10.40	10.34	12.01	13.78	15.11	16.12	15.77	14.17	12.89	11.92
	VPS	14.18	13.69	13.39	13.42	14.17	15.75	16.88	18.27	19.06	17.60	16.01	15.11
	CLD	70.25	64.40	67.54	62.31	62.34	58.60	59.03	53.75	53.92	45.90	63.33	73.40
40 N 127 W	SPD	9.05	8.05	9.28	7.94	7.89	8.03	8.58	8.30	7.54	8.34	7.55	7.66
	AIR	11.11	11.18	10.83	11.54	12.68	14.72	15.94	16.89	17.18	15.99	13.85	12.58
	SEA	12.15	11.69	11.35	11.66	12.63	14.29	15.62	16.64	17.10	16.58	14.82	13.75
	VPA	11.24	11.18	10.35	10.93	12.09	13.76	15.28	16.46	16.58	15.22	13.15	12.54
	VPS	14.22	13.78	13.47	13.75	14.66	16.36	17.85	19.04	19.60	18.94	16.92	15.82
	CLD	70.16	71.05	71.40	64.14	68.01	69.46	76.33	55.83	56.83	56.85	62.26	69.41
40 N 128 W	SPD	8.84	8.95	7.35	7.52	7.55	8.03	7.58	8.16	8.01	7.24	7.97	8.29
	AIR	11.75	10.95	10.85	11.09	12.62	14.79	16.12	17.58	17.44	16.34	14.22	12.93
	SEA	12.14	11.47	11.57	11.68	12.64	14.44	15.92	17.20	17.70	17.01	15.21	14.23
	VPA	11.19	11.00	10.32	10.70	12.11	13.74	15.61	16.88	16.58	15.30	13.15	12.44
	VPS	14.18	13.59	13.69	13.76	14.68	16.52	18.15	19.74	20.36	19.45	17.34	16.29
	CLD	73.80	64.64	72.15	66.49	70.64	71.87	76.99	68.83	56.19	52.08	64.19	62.63
40 N 129 W	SPD	8.86	7.45	8.26	7.90	7.49	7.27	7.60	7.75	7.82	7.72	8.09	7.93
	AIR	11.62	11.23	11.88	11.77	12.83	14.76	16.40	18.02	17.92	16.86	15.12	14.07
	SEA	12.57	11.62	12.42	12.16	13.08	14.96	16.37	17.79	18.25	17.59	16.15	15.45
	VPA	10.95	11.39	11.09	11.00	11.93	14.06	15.60	16.90	17.03	15.36	14.00	13.62
	VPS	14.63	13.72	14.46	14.23	15.11	17.09	18.68	20.46	21.04	20.16	18.45	17.68
	CLD	77.50	75.26	76.84	72.57	75.62	78.62	80.50	67.01	65.36	61.92	65.71	66.38
40 N 130 W	SPD	8.05	8.12	8.68	8.19	7.46	8.03	8.56	8.68	8.09	6.48	7.76	8.16
	AIR	12.85	11.75	12.03	12.21	13.11	14.88	16.55	17.98	17.99	17.24	15.23	13.70
	SEA	13.27	12.26	12.36	12.64	13.23	14.63	16.40	17.90	18.56	17.52	16.36	15.12
	VPA	12.56	11.10	11.46	10.92	11.78	13.80	15.53	16.83	16.61	16.37	14.57	12.83
	VPS	15.30	14.31	14.39	14.66	15.23	16.72	18.73	20.61	21.42	20.04	18.68	17.28
	CLD	70.13	68.83	76.87	74.80	81.59	82.89	81.76	78.18	73.64	68.50	66.68	69.86
40 N 131 W	SPD	8.74	8.78	8.53	7.71	6.48	7.01	7.16	6.32	7.37	7.26	7.93	9.13
	AIR	11.76	11.61	11.29	11.65	14.49	14.53	17.45	18.69	18.15	16.73	14.86	13.08
	SEA	13.10	12.00	12.04	12.41	13.68	14.72	17.18	18.64	18.58	17.58	16.09	14.48
	VPA	11.43	11.28	10.76	10.90	12.62	13.83	16.30	17.33	16.76	14.96	13.46	12.14
	VPS	15.15	14.06	14.11	14.47	15.70	16.82	19.67	21.59	21.47	20.16	18.40	16.55
	CLD	80.73	69.86	75.29	70.21	79.12	75.52	76.16	68.35	67.97	60.93	70.25	70.35
40 N 132 W	SPD	8.93	7.48	8.16	7.55	7.07	6.31	6.50	6.31	6.67	7.73	9.02	9.01
	AIR	11.40	11.51	11.05	11.42	13.05	14.72	16.71	18.50	18.31	17.08	14.73	12.88
	SEA	13.18	12.20	12.09	12.44	13.24	14.88	16.90	18.81	18.58	17.87	16.40	14.60
	VPA	11.09	11.24	10.62	10.90	12.18	13.81	15.61	17.48	16.97	16.03	13.59	11.97
	VPS	15.27	14.27	14.16	14.51	15.27	17.00	19.32	21.84	21.47	20.53	18.72	16.68
	CLD	80.35	75.00	73.77	73.85	73.35	80.44	80.60	76.39	65.02	69.11	70.02	68.90
40 N 133 W	SPD	9.09	8.18	8.98	6.93	6.69	6.06	6.39	6.38	6.98	6.87	8.41	9.22
	AIR	12.19	11.65	11.01	11.71	12.87	14.94	16.75	18.53	18.30	17.23	15.52	13.41
	SEA	13.54	12.63	11.93	12.77	13.12	14.96	16.80	18.86	18.49	17.78	16.55	14.75
	VPA	11.72	11.43	10.58	10.58	11.96	14.08	16.17	17.66	16.79	15.77	14.47	12.63
	VPS	15.59	14.68	14.00	14.82	15.16	17.06	19.22	21.87	21.36	20.40	18.90	16.85
	CLD	75.85	71.83	77.56	76.04	75.96	75.58	83.46	77.38	70.20	67.58	73.42	78.68

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
41 N	SPD	7.12	7.13	7.31	6.45	6.47	8.60	9.18	5.72	5.17	7.13	6.78	6.89
124 W	AIR	10.11	9.44	10.63	10.70	11.78	12.86	13.31	14.39	13.84	13.22	11.90	10.77
	SEA	10.87	10.41	10.76	10.70	10.89	11.27	11.64	12.69	13.80	12.77	12.35	11.95
	VPA	10.36	9.72	10.62	10.50	11.49	12.76	13.55	14.54	14.32	12.77	12.14	10.85
	VPS	13.05	12.66	12.95	12.88	13.08	13.44	13.80	14.81	15.95	14.91	14.39	14.03
	CLD	71.71	44.04	62.50	67.30	52.60	48.00	56.73	51.56	56.25	50.54	52.20	61.25
41 N	SPD	8.01	8.33	7.38	7.73	8.15	7.92	8.77	7.41	7.21	6.83	7.50	8.80
125 W	AIR	10.09	10.47	10.83	10.93	12.27	13.52	14.33	14.81	14.80	13.72	12.71	11.11
	SEA	11.19	10.80	10.85	10.85	11.53	12.36	12.61	13.29	13.59	13.08	12.88	11.77
	VPA	10.02	10.46	10.24	10.53	11.83	13.08	14.19	14.88	14.29	12.94	12.54	11.11
	VPS	13.35	13.00	13.04	13.06	13.67	14.47	14.74	15.43	15.72	15.15	14.92	13.88
	CLD	65.18	68.45	61.05	54.13	55.53	55.54	59.64	50.32	45.09	45.25	59.39	68.23
41 N	SPD	9.32	8.07	8.13	8.71	8.10	8.05	7.84	7.89	8.08	8.96	7.50	9.23
126 W	AIR	10.54	11.10	11.19	10.70	12.26	14.56	15.37	16.63	16.31	14.69	12.78	10.79
	SEA	11.00	10.85	10.78	11.22	11.77	13.43	14.79	15.80	15.63	14.47	13.22	12.04
	VPA	10.48	10.99	10.70	10.18	11.67	13.67	14.42	16.40	15.76	14.10	12.54	10.77
	VPS	13.17	13.04	12.98	13.36	13.86	15.51	16.93	18.04	17.93	16.56	15.28	14.10
	CLD	68.75	65.54	73.00	68.93	65.86	57.21	62.67	57.72	46.59	58.39	55.66	67.72
41 N	SPD	9.63	8.72	9.05	7.94	8.08	8.54	9.02	8.02	8.92	7.39	9.69	9.07
127 W	AIR	10.56	10.38	10.29	11.03	11.79	14.34	16.16	17.16	16.91	14.80	13.32	11.98
	SEA	11.56	10.81	10.59	11.37	11.93	13.53	15.36	16.35	16.86	15.63	13.88	13.04
	VPA	10.30	10.93	10.16	10.06	11.05	13.54	14.90	16.60	15.57	13.79	12.25	11.53
	VPS	13.68	13.00	12.82	13.48	14.01	15.58	17.54	18.72	19.31	17.83	15.97	15.09
	CLD	75.00	72.22	68.45	73.46	67.94	71.38	71.46	57.58	40.15	55.23	59.12	69.07
41 N	SPD	9.44	6.86	8.87	7.00	7.83	7.64	8.17	7.30	6.59	7.63	9.00	8.54
128 W	AIR	11.28	10.78	10.24	10.97	12.34	14.56	16.08	17.38	17.99	15.68	13.74	12.18
	SEA	12.10	11.48	11.08	11.29	12.23	14.19	15.85	17.07	17.89	16.12	15.09	13.19
	VPA	11.25	11.42	10.38	10.11	11.96	13.65	15.83	16.80	16.70	14.49	13.09	11.64
	VPS	14.16	13.62	13.23	13.41	14.29	16.29	18.08	19.56	20.55	18.40	17.24	15.24
	CLD	58.12	75.41	62.86	71.75	73.80	70.58	80.76	63.55	65.05	58.15	67.81	66.66
41 N	SPD	9.97	9.70	8.16	6.54	7.16	6.78	7.23	7.09	7.02	8.06	8.33	9.41
129 W	AIR	11.34	10.23	10.47	11.05	12.27	14.89	16.00	17.69	17.90	16.37	14.80	12.63
	SEA	12.16	11.37	11.09	11.39	12.36	14.48	16.17	17.51	18.05	17.07	15.88	13.73
	VPA	11.56	10.60	10.42	10.60	11.96	13.82	15.17	17.05	16.74	15.39	14.44	11.89
	VPS	14.23	13.49	13.24	13.51	14.41	16.56	18.48	20.09	20.78	19.52	18.11	15.80
	CLD	78.07	73.93	72.80	68.58	64.50	71.26	79.30	72.88	69.59	63.55	64.15	70.83
41 N	SPD	9.57	9.36	8.23	6.83	7.08	7.17	7.13	7.02	7.32	7.28	7.55	8.24
130 W	AIR	11.27	10.59	10.59	11.22	12.27	14.28	16.19	17.82	17.75	16.86	14.55	12.72
	SEA	12.47	11.43	11.21	11.63	12.40	14.49	16.14	17.66	18.12	17.47	15.50	13.78
	VPA	10.83	10.57	10.26	10.50	11.64	13.40	15.51	16.91	16.50	15.98	13.18	12.42
	VPS	14.50	13.55	13.36	13.72	14.45	16.58	18.43	20.29	20.86	20.03	17.66	15.82
	CLD	79.61	72.24	75.26	73.10	71.30	77.24	74.11	69.82	66.95	58.77	68.35	60.71
41 N	SPD	9.56	9.90	9.21	7.55	6.90	6.31	6.48	6.59	7.09	7.57	9.11	9.08
131 W	AIR	11.87	11.23	10.49	10.67	12.17	14.57	16.46	18.14	18.48	16.82	14.91	12.27
	SEA	11.89	11.25	11.30	11.31	12.20	14.38	16.67	18.11	18.59	17.28	15.84	13.96
	VPA	11.35	11.35	10.27	10.69	11.71	13.83	15.50	17.15	17.59	15.42	13.78	11.84
	VPS	13.99	13.39	13.45	13.47	14.26	16.43	19.06	20.88	21.50	19.80	18.07	16.01
	CLD	82.93	74.29	76.56	72.90	75.08	75.72	80.91	71.75	75.51	65.20	71.55	74.85
41 N	SPD	8.90	9.32	9.05	7.97	7.47	6.19	6.64	6.71	7.69	7.29	9.03	10.85
132 W	AIR	11.30	11.09	10.14	10.86	12.19	14.28	16.28	17.92	17.83	16.50	14.52	12.67
	SEA	12.50	11.68	11.25	11.27	12.22	14.53	16.53	18.42	18.64	17.50	15.94	13.94
	VPA	11.23	11.48	10.16	10.56	11.70	13.45	15.79	17.08	16.87	15.13	13.55	12.23
	VPS	14.54	13.79	13.40	13.40	14.28	16.60	18.90	21.31	21.58	20.06	18.18	15.99
	CLD	80.44	80.38	77.11	74.03	80.19	79.21	83.87	75.29	73.51	68.31	75.48	75.84
41 N	SPD	9.87	9.27	9.67	7.13	7.16	6.38	6.45	5.53	6.89	8.41	9.43	9.20
133 W	AIR	11.03	11.25	10.52	11.15	12.09	14.13	16.65	18.08	18.12	16.66	14.25	12.98
	SEA	12.48	11.60	11.95	11.81	12.48	14.57	16.22	18.34	18.52	17.70	15.60	14.12
	VPA	10.80	11.43	10.59	10.78	11.56	13.22	16.12	17.16	16.45	14.98	13.29	12.49
	VPS	14.59	13.71	14.04	13.90	14.52	16.65	18.51	21.17	21.41	20.28	17.79	16.18
	CLD	77.77	78.07	77.08	74.26	77.92	81.58	82.98	72.78	69.37	69.05	81.65	74.15

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
42 N 124 W	SPD	7.72	9.45	7.46	5.75	7.34	5.88	9.10	5.31	5.35	6.85	8.71	7.27
	AIR	8.99	8.71	10.49	9.50	11.16	13.53	12.84	16.72	13.73	13.67	12.12	10.45
	SEA	10.48	9.98	10.25	10.16	10.47	12.09	11.96	14.93	12.07	12.64	12.72	10.89
	VPA	10.17	8.93	10.60	9.22	10.79	13.04	13.04	15.91	13.64	12.93	12.53	10.15
	VPS	12.72	12.31	12.54	12.42	12.74	14.17	14.23	17.12	14.14	14.76	14.76	13.07
	CLD	71.15	67.10	58.75	50.00	52.27	59.50	40.86	32.66	67.04	50.65	63.39	67.18
42 N 125 W	SPD	8.27	7.40	7.53	7.94	9.10	8.04	9.39	7.52	7.61	6.87	7.55	8.28
	AIR	9.81	10.26	10.15	10.61	12.02	13.47	13.85	14.78	14.64	13.61	12.58	10.81
	SEA	10.78	10.54	10.60	10.65	11.29	12.30	12.75	13.19	13.63	13.06	12.85	11.78
	VPA	9.69	10.31	9.98	10.24	11.40	13.06	13.83	14.62	14.37	13.14	12.30	10.47
	VPS	12.98	12.77	12.84	12.86	13.45	14.42	14.87	15.32	15.79	15.11	14.89	13.90
	CLD	69.64	75.40	57.37	58.51	48.78	54.60	46.28	50.18	43.42	47.05	63.62	66.93
42 N 126 W	SPD	8.43	8.31	8.50	7.55	8.47	7.60	7.71	8.40	8.18	7.67	7.45	8.21
	AIR	9.82	10.32	10.63	11.13	12.57	14.59	15.98	17.50	16.21	14.64	12.57	11.14
	SEA	11.07	10.82	10.79	10.91	11.97	13.76	14.78	16.07	14.79	14.07	13.08	11.82
	VPA	10.16	10.50	10.63	10.72	11.42	13.76	14.87	16.47	15.54	13.94	12.33	11.01
	VPS	13.23	13.01	12.98	13.08	14.05	15.81	16.92	18.40	17.00	16.18	15.10	13.97
	CLD	63.81	64.93	68.43	66.66	61.45	70.19	69.72	58.42	43.14	49.37	58.88	71.12
42 N 127 W	SPD	9.99	6.86	8.55	9.14	7.07	7.96	7.55	7.00	8.49	8.67	8.11	9.07
	AIR	9.56	10.11	10.22	10.62	12.04	14.25	16.03	17.28	16.64	14.86	12.57	10.98
	SEA	10.64	10.68	10.46	10.84	11.67	13.47	15.30	16.99	16.44	15.30	13.22	12.52
	VPA	9.98	10.11	10.27	9.55	11.12	13.07	15.01	16.51	16.06	13.89	12.46	10.75
	VPS	12.85	12.91	12.70	13.02	13.80	15.50	17.45	19.45	18.86	17.46	15.26	14.61
	CLD	67.44	68.42	70.77	67.04	75.24	73.28	63.15	71.35	52.69	56.91	69.82	70.62
42 N 128 W	SPD	8.12	7.61	7.52	8.16	6.86	8.58	7.66	7.97	5.92	7.76	8.54	9.80
	AIR	10.55	10.18	9.89	10.21	11.65	14.41	15.43	17.96	17.33	15.82	13.66	10.89
	SEA	11.17	10.67	10.39	10.97	11.80	13.82	15.58	17.48	17.15	16.08	14.55	12.46
	VPA	10.57	10.55	10.22	9.73	11.19	14.05	14.59	16.57	15.94	14.39	12.79	10.58
	VPS	13.39	12.88	12.66	13.13	13.88	15.87	17.78	20.07	19.62	18.33	16.66	14.53
	CLD	67.30	73.92	71.87	61.98	72.72	71.73	77.67	68.22	65.00	53.50	69.68	70.83
42 N 129 W	SPD	7.98	8.97	8.27	7.29	8.10	7.26	7.82	5.89	7.78	8.67	8.89	8.44
	AIR	10.68	10.41	10.03	12.18	12.15	13.54	16.19	18.44	17.69	15.50	13.29	12.53
	SEA	11.66	11.26	10.70	11.36	12.32	13.57	15.81	16.92	17.59	16.29	14.86	13.62
	VPA	11.12	10.52	9.74	11.64	11.58	12.73	15.23	17.71	16.12	14.60	12.47	12.27
	VPS	13.74	13.39	12.90	13.47	14.35	15.59	17.99	19.33	20.20	18.60	16.95	15.63
	CLD	69.72	68.61	77.50	79.19	83.66	76.33	72.17	64.40	61.39	65.11	72.06	77.50
42 N 130 W	SPD	8.66	8.14	8.56	6.96	7.31	7.03	6.70	6.83	7.29	7.86	9.89	9.13
	AIR	10.35	10.56	9.96	10.21	11.84	13.55	15.73	18.09	17.53	16.10	14.01	11.97
	SEA	11.71	11.11	10.98	10.74	12.20	13.95	15.90	18.13	17.98	17.25	15.59	13.21
	VPA	10.57	10.86	9.61	10.40	11.35	12.97	15.01	16.65	16.41	15.02	13.07	11.40
	VPS	13.82	13.27	13.16	12.95	14.28	15.98	18.13	20.87	20.65	19.80	17.76	15.24
	CLD	68.98	77.46	73.07	78.18	81.83	81.66	80.00	72.95	69.93	66.50	69.24	75.73
42 N 131 W	SPD	8.88	9.61	8.26	7.14	6.76	6.46	6.88	6.05	7.24	7.34	8.88	10.10
	AIR	11.53	10.91	9.74	10.36	12.02	14.25	16.29	18.00	17.98	16.44	14.90	12.38
	SEA	11.26	11.39	10.91	10.50	11.95	14.20	16.67	18.48	19.05	16.57	15.30	13.99
	VPA	11.24	11.54	9.58	10.70	11.58	14.10	15.93	17.41	16.92	15.05	13.76	12.09
	VPS	13.41	13.54	13.14	12.74	14.02	16.23	19.07	21.35	22.12	18.92	17.45	16.09
	CLD	73.19	78.12	76.41	72.56	69.88	81.86	83.11	70.75	72.07	63.63	71.71	76.10
42 N 132 W	SPD	10.92	10.56	9.28	7.93	6.88	6.25	6.87	6.21	6.59	7.66	9.37	9.18
	AIR	10.83	10.88	9.62	10.22	11.97	13.94	16.21	17.76	17.65	16.54	14.02	12.33
	SEA	11.76	11.18	10.72	10.73	12.02	14.16	16.44	18.01	18.20	17.07	15.16	13.59
	VPA	11.03	11.34	9.87	10.28	11.29	13.07	15.44	16.83	16.49	15.40	13.31	12.03
	VPS	13.85	13.33	12.92	12.95	14.10	16.22	18.79	20.74	20.96	19.52	17.28	15.64
	CLD	78.07	81.06	72.10	69.55	73.60	79.88	82.45	73.83	63.70	69.82	79.04	77.05
42 N 133 W	SPD	11.04	9.85	9.61	7.94	7.87	6.29	6.12	5.81	6.87	7.71	9.53	10.53
	AIR	10.99	10.38	10.04	10.40	11.98	13.80	15.84	17.66	17.71	16.57	14.12	11.73
	SEA	11.86	11.18	10.81	11.01	11.89	14.17	16.22	17.93	18.17	17.26	15.02	13.31
	VPA	10.80	10.42	9.97	10.46	11.41	13.06	15.09	16.82	16.61	15.52	13.44	11.06
	VPS	13.95	13.34	13.00	13.18	13.97	16.25	18.53	20.64	20.92	19.76	17.17	15.33
	CLD	80.89	75.53	72.54	78.52	77.32	84.13	79.40	76.87	70.32	70.18	81.89	72.22

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
43 N	SPD	6.79	7.97	6.94	7.03	6.92	5.93	8.71	5.72	6.15	5.68	8.55	6.69
124 W	AIR	9.17	8.74	9.28	9.91	11.53	13.53	15.04	14.73	15.36	13.39	12.47	8.18
	SEA	10.78	9.90	10.06	10.13	11.81	12.85	12.17	13.42	12.23	13.26	12.31	9.84
	VPA	9.98	9.65	10.15	9.59	11.57	13.30	14.85	14.28	13.64	13.89	11.75	8.69
	VPS	13.02	12.22	12.41	12.40	13.92	14.93	14.31	15.56	14.29	15.27	14.40	12.21
	CLD	65.00	61.87	52.50	69.16	65.38	75.00	39.42	60.15	36.56	58.12	75.00	48.21
43 N	SPD	8.73	8.77	8.21	7.01	8.06	7.73	7.13	6.17	6.96	6.76	7.02	8.34
125 W	AIR	9.29	9.81	9.73	10.32	11.85	13.69	14.63	15.23	14.60	13.52	12.11	10.47
	SEA	10.50	10.15	10.56	10.42	11.37	12.62	13.08	14.24	13.39	13.25	12.52	11.32
	VPA	9.85	10.05	9.92	10.04	11.56	13.24	14.46	15.24	14.11	12.89	12.10	10.39
	VPS	12.74	12.45	12.80	12.66	13.52	14.74	15.22	16.43	15.51	15.31	14.58	13.47
	CLD	77.26	77.36	63.41	65.44	66.27	64.27	55.44	55.03	41.95	52.23	62.97	67.54
43 N	SPD	9.64	9.00	7.52	6.27	7.35	7.70	8.29	7.56	7.29	7.47	7.85	8.23
126 W	AIR	10.16	9.86	10.22	10.72	12.65	14.75	16.18	16.93	16.06	13.82	12.89	10.92
	SEA	10.38	10.07	10.45	10.86	12.01	14.24	15.42	16.07	16.51	13.93	12.61	11.44
	VPA	10.61	10.55	9.67	9.69	11.63	13.62	15.57	16.26	15.23	12.82	12.46	10.39
	VPS	12.63	12.37	12.69	13.04	14.08	16.29	17.63	18.34	18.89	15.97	14.64	13.57
	CLD	70.07	80.46	69.48	66.28	71.05	82.08	65.62	49.21	44.16	53.03	65.06	64.35
43 N	SPD	10.58	10.10	8.18	7.75	6.97	5.89	7.14	8.66	7.29	7.56	7.13	10.22
127 W	AIR	9.51	9.72	9.82	10.24	12.12	14.18	16.11	17.76	17.14	14.89	11.79	10.54
	SEA	10.43	10.26	10.01	10.61	11.61	13.99	15.62	17.28	17.19	15.01	12.57	11.47
	VPA	10.10	9.98	9.74	9.53	11.06	13.34	14.90	16.06	16.25	13.81	11.71	10.59
	VPS	12.66	12.53	12.33	12.82	13.71	16.05	17.81	19.81	19.67	17.16	14.61	13.58
	CLD	89.02	78.75	76.65	73.36	71.78	73.79	66.56	73.43	55.60	63.67	69.64	81.94
43 N	SPD	8.85	9.34	9.63	8.45	6.59	6.72	7.59	6.30	7.66	8.30	9.07	9.98
128 W	AIR	9.40	9.52	9.55	10.01	11.67	13.67	15.89	17.61	17.07	14.98	12.86	10.54
	SEA	10.77	10.09	10.07	10.12	11.39	13.20	15.70	17.50	17.09	15.34	13.43	11.89
	VPA	9.40	9.81	9.70	9.57	11.04	13.07	15.13	16.76	15.77	14.04	11.60	10.16
	VPS	12.97	12.41	12.40	12.43	13.50	15.23	17.93	20.05	19.58	17.56	15.48	13.98
	CLD	77.13	77.50	69.89	79.26	76.30	79.16	71.51	64.32	65.05	71.39	68.65	71.12
43 N	SPD	9.35	7.93	8.00	7.08	7.68	7.22	6.88	6.88	7.19	7.62	8.85	10.25
129 W	AIR	10.07	10.12	9.32	10.01	11.42	13.97	16.02	17.63	17.57	15.51	12.75	10.83
	SEA	11.42	10.43	10.12	10.19	11.47	13.74	15.63	17.82	17.38	16.37	14.21	12.35
	VPA	10.28	10.25	9.78	9.98	11.07	12.93	14.53	16.34	15.97	13.88	12.12	11.10
	VPS	13.58	12.71	12.42	12.46	13.59	15.78	17.84	20.53	19.91	18.70	16.26	14.48
	CLD	75.59	76.56	78.88	70.83	77.08	80.58	75.50	73.65	62.69	60.00	68.54	78.27
43 N	SPD	10.36	9.07	9.57	8.53	6.89	5.85	7.17	6.02	7.72	8.25	9.08	9.15
130 W	AIR	10.95	10.31	9.64	9.66	11.30	13.57	16.13	18.08	17.77	16.04	13.09	11.82
	SEA	12.35	10.89	10.51	10.48	11.85	13.98	16.43	17.92	18.19	17.18	14.60	13.34
	VPA	11.30	10.67	9.98	9.52	10.73	12.94	15.34	16.97	15.77	14.60	12.26	11.55
	VPS	14.41	13.08	12.73	12.70	13.93	16.01	18.72	20.59	20.92	19.66	16.67	15.37
	CLD	80.01	82.10	73.17	79.42	81.61	75.19	77.22	77.94	68.50	70.27	69.81	78.33
43 N	SPD	9.25	9.61	8.93	7.79	6.90	6.45	6.18	5.52	7.37	8.22	8.90	10.10
131 W	AIR	10.43	10.29	9.47	10.17	11.91	14.33	16.33	18.13	17.91	15.90	13.79	11.16
	SEA	10.88	10.57	10.41	10.27	11.70	13.98	16.24	18.44	18.45	16.57	14.67	12.72
	VPA	10.58	11.12	9.64	10.64	11.41	13.82	15.85	17.31	16.53	14.48	12.48	10.86
	VPS	13.09	12.81	12.70	12.54	13.78	16.02	18.52	21.30	21.32	18.93	16.84	14.79
	CLD	81.25	76.19	75.31	75.36	81.68	83.53	83.75	69.22	74.12	74.06	76.56	77.27
43 N	SPD	10.39	11.40	9.48	8.07	7.26	6.46	5.20	6.07	7.16	8.37	8.67	11.08
132 W	AIR	9.79	10.31	9.48	9.94	11.32	13.27	15.81	17.89	17.27	15.39	13.04	10.77
	SEA	10.95	10.07	10.34	10.47	11.53	13.35	16.14	17.88	17.87	16.63	14.76	12.78
	VPA	10.36	10.77	9.76	9.74	11.01	12.78	15.16	17.30	15.92	14.20	12.50	10.48
	VPS	13.13	12.38	12.61	12.71	13.64	15.37	18.42	20.57	20.56	18.99	16.87	14.85
	CLD	79.79	79.68	78.08	75.00	79.38	82.50	83.33	75.73	72.64	80.92	72.70	69.95
43 N	SPD	9.23	10.41	8.00	7.76	6.82	6.34	5.67	6.00	6.63	8.81	8.86	9.17
133 W	AIR	9.56	9.89	9.36	10.34	12.02	13.15	15.53	17.19	17.24	15.41	13.80	11.26
	SEA	11.00	10.37	10.24	10.58	11.58	13.46	15.69	17.73	17.53	16.69	14.69	12.50
	VPA	9.91	10.02	9.55	10.24	11.70	12.58	14.81	16.50	16.38	14.43	12.80	11.33
	VPS	13.16	12.62	12.53	12.80	13.69	15.50	17.89	20.35	20.10	19.05	16.81	14.57
	CLD	73.61	66.17	73.09	75.00	78.01	84.72	84.32	81.03	62.75	73.21	69.02	68.65

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
44 N	SPD	7.23	7.49	8.16	6.11	5.76	4.82	5.35	3.26	5.52	5.04	6.51	7.18
124 W	AIR	8.09	8.58	9.55	9.95	10.80	13.56	13.79	14.49	15.21	13.34	11.74	9.49
	SEA	9.60	9.72	9.85	10.06	10.92	13.14	12.41	13.19	14.20	12.65	12.51	10.90
	VPA	8.20	9.14	9.83	9.77	10.64	13.08	13.76	14.71	14.44	12.79	11.52	10.05
	VPS	11.99	12.08	12.20	12.35	13.08	15.24	14.59	15.39	16.35	14.70	14.54	13.14
	CLD	69.88	73.61	68.10	59.64	66.56	63.00	50.96	66.66	49.43	46.98	65.20	79.16
44 N	SPD	9.50	7.91	8.21	7.03	7.04	6.20	6.77	6.34	6.29	6.23	6.97	9.84
125 W	AIR	8.72	9.12	9.61	9.96	12.11	14.61	15.47	15.91	15.77	13.65	11.87	10.18
	SEA	10.17	10.05	10.17	10.53	11.74	13.78	14.30	15.40	15.03	13.36	12.36	11.04
	VPA	9.36	9.63	9.74	9.81	11.54	13.50	14.97	15.39	15.01	12.99	11.64	10.33
	VPS	12.46	12.36	12.47	12.76	13.86	15.86	16.47	17.66	17.22	15.43	14.40	13.21
	CLD	78.36	76.64	65.37	72.37	62.59	67.18	58.51	57.46	50.00	58.43	62.72	75.00
44 N	SPD	7.51	8.31	7.33	7.20	5.92	6.84	7.84	6.18	6.97	8.90	8.14	10.62
126 W	AIR	10.18	9.80	9.52	10.48	12.07	14.48	16.13	17.13	17.15	13.96	12.30	10.19
	SEA	10.65	10.35	10.23	10.42	11.72	14.12	16.26	16.81	16.85	14.20	12.64	11.16
	VPA	10.92	10.08	9.34	10.13	10.95	13.05	15.02	16.04	16.35	12.72	12.13	10.30
	VPS	12.88	12.61	12.51	12.65	13.83	16.17	18.61	19.25	19.25	16.30	14.65	13.33
	CLD	70.41	69.71	61.93	65.71	66.32	75.58	71.22	60.67	63.88	59.84	57.85	68.50
44 N	SPD	9.71	7.55	7.68	7.80	6.00	6.16	7.17	6.40	6.88	8.91	8.40	10.68
127 W	AIR	9.78	9.74	8.99	9.58	11.70	13.24	15.81	17.36	17.63	15.06	12.31	10.38
	SEA	10.71	9.96	9.80	10.28	11.70	14.16	16.08	17.61	17.62	14.93	12.84	11.17
	VPA	10.25	10.51	9.07	9.73	10.98	12.66	14.73	15.38	16.19	13.94	12.56	10.77
	VPS	12.97	12.31	12.15	12.56	13.78	16.22	18.32	20.18	20.21	17.13	14.90	13.35
	CLD	79.60	70.41	66.47	77.91	71.03	83.75	75.83	68.20	48.82	78.94	77.43	76.04
44 N	SPD	9.60	8.26	9.25	7.64	6.84	6.33	7.08	6.63	6.86	8.29	9.01	9.86
128 W	AIR	8.54	8.80	8.89	9.73	11.52	13.45	15.43	17.36	17.06	15.22	12.99	10.35
	SEA	10.09	9.42	9.67	10.10	11.53	13.77	16.10	17.51	17.29	15.74	13.77	11.68
	VPA	9.33	9.58	9.22	9.52	10.95	13.07	14.73	15.78	16.04	14.39	12.59	10.54
	VPS	12.39	11.86	12.05	12.41	13.65	15.81	18.35	20.08	19.78	17.93	15.79	13.80
	CLD	76.85	79.54	71.07	73.26	73.49	82.32	80.76	67.18	59.30	73.54	68.52	76.92
44 N	SPD	9.13	9.58	8.71	8.15	6.03	6.46	6.34	6.69	6.97	7.72	9.08	10.97
129 W	AIR	8.97	9.40	8.96	9.04	11.55	13.45	15.58	16.96	16.87	14.95	12.99	10.13
	SEA	10.24	9.69	9.56	9.63	11.44	13.27	15.81	17.50	17.76	15.91	13.81	11.65
	VPA	9.47	9.69	9.50	9.20	11.05	12.65	14.46	16.00	16.12	13.65	12.01	10.43
	VPS	12.53	12.07	12.00	12.03	13.61	15.32	18.06	20.05	20.40	18.14	15.85	13.77
	CLD	75.00	76.20	65.72	75.00	72.56	77.42	75.51	75.86	60.12	69.57	68.97	73.90
44 N	SPD	9.56	9.58	9.28	8.52	6.65	6.59	6.96	6.25	7.30	8.63	9.70	9.35
130 W	AIR	9.30	9.43	9.23	9.43	11.30	13.44	15.32	17.11	17.00	14.94	13.05	10.83
	SEA	10.59	9.82	9.52	9.42	11.23	12.99	15.55	17.39	17.53	15.51	14.44	12.28
	VPA	9.68	10.06	9.65	9.32	10.83	12.64	14.48	15.90	15.58	13.71	12.35	10.43
	VPS	12.84	12.19	11.93	11.86	13.43	15.03	17.74	19.94	20.09	17.71	16.52	14.35
	CLD	77.10	75.64	74.82	70.04	72.27	80.03	82.58	79.54	71.91	74.00	72.40	74.65
44 N	SPD	10.04	9.10	8.27	7.21	7.18	6.62	6.13	5.35	7.34	8.86	7.69	9.78
131 W	AIR	9.70	9.74	9.17	9.76	11.84	13.66	15.57	17.67	17.27	14.97	12.64	11.36
	SEA	10.54	10.18	9.51	10.02	11.42	12.66	15.48	17.64	17.80	15.86	13.44	12.15
	VPA	10.18	10.38	9.81	10.06	12.13	13.62	15.49	17.34	16.90	13.60	12.22	11.36
	VPS	12.81	12.49	11.94	12.40	13.54	14.76	17.67	20.29	20.44	18.10	15.47	14.23
	CLD	76.14	79.28	71.93	70.43	72.43	82.16	81.98	74.05	73.36	70.99	75.94	82.98
44 N	SPD	10.58	10.41	9.43	7.05	6.56	6.49	5.67	5.59	6.74	8.06	9.43	10.88
132 W	AIR	9.24	9.52	9.27	9.63	11.40	13.92	15.48	17.31	17.21	15.20	12.50	10.51
	SEA	10.46	9.86	10.04	9.57	11.43	13.44	15.42	17.77	17.39	16.10	13.75	11.87
	VPA	9.66	9.97	9.73	10.10	11.31	13.57	14.73	16.37	16.58	14.05	11.85	10.79
	VPS	12.72	12.21	12.36	11.96	13.55	15.54	17.59	20.40	19.91	18.37	15.78	13.99
	CLD	78.23	85.11	72.91	66.34	79.07	76.28	83.59	69.44	68.56	64.06	73.40	74.53
44 N	SPD	10.16	10.43	9.12	8.27	6.61	7.12	5.29	6.05	6.89	8.27	8.40	10.18
133 W	AIR	9.39	9.43	9.22	9.57	11.23	13.34	15.22	17.01	16.95	14.91	12.79	10.43
	SEA	10.72	9.90	9.84	9.84	11.14	13.58	15.42	17.51	17.56	15.85	14.16	12.03
	VPA	10.13	9.95	9.75	9.28	10.99	12.60	14.39	16.02	15.93	13.26	11.96	10.73
	VPS	12.95	12.23	12.21	12.17	13.31	15.66	17.59	20.07	20.14	18.08	16.23	14.11
	CLD	79.12	74.34	82.68	69.77	82.18	83.43	84.37	84.07	80.59	72.01	70.83	80.19

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
45 N	SPD	7.67	7.42	7.15	6.73	6.03	5.64	4.82	4.89	5.41	5.61	7.96	6.60
124 W	AIR	7.87	9.02	8.84	9.41	11.91	13.69	15.19	15.22	15.22	13.03	11.25	8.66
	SEA	9.94	9.67	9.94	10.37	11.71	13.25	13.63	14.18	14.49	13.30	11.86	10.87
	VPA	8.82	9.63	9.00	9.52	11.20	12.88	14.50	14.86	14.71	12.56	10.93	9.26
	VPS	12.26	12.04	12.28	12.63	13.82	15.34	15.76	16.27	16.60	15.36	13.94	13.06
	CLD	78.67	71.38	72.65	65.27	64.88	73.39	58.39	49.72	59.45	57.87	70.31	76.00
45 N	SPD	9.29	7.23	7.80	7.00	6.49	6.01	6.46	5.35	6.12	6.71	7.31	8.49
125 W	AIR	8.98	9.19	9.05	10.01	12.09	14.29	15.81	16.46	15.94	13.58	11.74	9.70
	SEA	10.04	9.87	9.80	10.06	12.02	14.45	15.27	15.90	15.50	13.96	12.24	10.70
	VPA	9.52	9.43	9.26	9.77	11.30	13.49	15.03	15.73	14.85	12.85	11.39	9.90
	VPS	12.35	12.21	12.15	12.37	14.09	16.56	17.46	18.19	17.71	16.02	14.28	12.92
	CLD	82.82	66.29	68.14	70.88	66.95	78.19	70.31	59.44	57.08	57.85	69.86	67.28
45 N	SPD	8.70	7.12	8.45	7.29	5.63	6.15	7.28	6.21	7.13	7.23	7.60	8.65
126 W	AIR	8.83	9.46	8.70	9.44	11.84	14.10	16.13	17.12	15.58	13.45	12.09	9.47
	SEA	10.21	9.94	9.97	10.06	11.97	14.18	16.22	17.24	16.31	14.50	13.16	10.61
	VPA	9.31	9.69	9.19	9.48	11.12	12.90	14.74	15.94	13.71	11.93	11.12	9.52
	VPS	12.50	12.27	12.31	12.36	14.05	16.24	18.53	19.75	18.60	16.60	15.21	12.83
	CLD	79.00	71.66	74.48	73.38	71.06	76.44	67.75	67.57	60.32	52.90	66.58	75.48
45 N	SPD	11.53	8.59	9.16	7.06	6.58	5.94	7.27	5.72	6.94	7.67	8.04	10.21
127 W	AIR	9.21	8.89	8.90	9.07	11.27	13.43	15.83	17.11	17.07	14.36	11.65	9.88
	SEA	9.98	9.62	9.53	9.77	11.54	14.00	16.16	17.74	17.12	15.09	12.70	11.52
	VPA	9.71	9.56	9.14	9.26	10.58	12.19	14.62	15.83	15.93	13.07	11.17	10.13
	VPS	12.31	12.01	11.93	12.13	13.68	16.04	18.42	20.38	19.61	17.23	14.73	13.69
	CLD	78.97	73.56	74.32	78.23	71.37	87.50	75.00	70.51	68.08	60.03	62.50	75.98
45 N	SPD	9.34	8.92	10.38	7.34	6.25	6.23	6.86	6.55	7.52	8.68	8.78	10.79
128 W	AIR	8.56	9.12	8.17	9.37	11.41	13.14	15.71	16.66	17.27	14.47	12.21	10.60
	SEA	10.25	9.47	9.40	9.63	11.33	13.40	16.20	17.54	17.60	15.59	13.06	11.46
	VPA	9.09	9.61	8.91	10.11	11.10	12.70	14.70	15.72	16.17	13.38	11.75	10.63
	VPS	12.52	11.88	11.86	12.01	13.47	15.47	18.48	20.08	20.21	17.81	15.09	13.62
	CLD	78.18	81.79	76.62	74.09	73.58	85.99	79.24	75.88	63.10	71.66	68.92	79.68
45 N	SPD	8.88	8.71	9.24	8.05	6.06	6.26	7.00	5.77	7.41	8.62	9.37	9.63
129 W	AIR	8.79	9.09	8.81	8.93	10.65	12.94	14.95	17.08	16.66	14.26	11.96	10.32
	SEA	9.81	9.54	9.47	9.40	10.52	13.02	14.82	17.24	17.04	15.12	13.20	11.62
	VPA	9.57	10.06	9.13	9.05	10.36	12.32	13.96	16.08	15.42	13.18	11.62	10.45
	VPS	12.16	11.96	11.89	11.84	12.76	15.06	16.92	19.73	19.50	17.24	15.24	13.76
	CLD	80.59	77.12	71.67	68.16	78.50	79.22	78.67	76.25	68.52	66.79	71.29	83.66
45 N	SPD	9.08	8.83	8.44	8.49	5.93	5.73	6.88	6.67	5.83	8.39	9.74	10.27
130 W	AIR	9.96	9.73	9.44	9.92	11.47	13.77	15.27	16.57	16.54	15.05	13.02	10.96
	SEA	11.38	10.45	10.20	10.24	10.74	12.93	14.24	16.39	16.67	16.09	14.39	12.07
	VPA	10.06	10.11	9.55	9.76	10.70	12.65	14.36	15.54	15.36	14.21	12.16	10.68
	VPS	13.52	12.70	12.49	12.52	12.93	14.96	16.30	18.68	19.03	18.37	16.48	14.17
	CLD	79.48	80.94	72.72	76.47	74.48	83.47	83.49	77.97	66.88	71.13	78.57	76.90
45 N	SPD	9.91	9.24	8.46	7.87	6.44	6.69	6.69	6.03	7.24	7.57	8.21	9.96
131 W	AIR	9.25	9.00	8.91	9.28	11.09	13.80	15.41	17.58	16.68	14.70	12.39	10.39
	SEA	10.23	10.00	9.33	9.40	11.12	13.37	15.29	17.72	17.10	15.55	13.41	11.37
	VPA	9.72	9.99	9.47	9.40	11.22	13.52	14.83	16.97	16.08	13.62	11.76	10.51
	VPS	12.55	12.35	11.79	11.85	13.29	15.42	17.43	20.38	19.55	17.73	15.45	13.50
	CLD	75.00	75.23	75.15	71.53	76.64	83.10	85.56	74.55	65.97	76.25	74.67	75.92
45 N	SPD	10.38	9.35	8.70	8.02	6.96	6.49	5.91	6.23	7.13	8.19	9.18	10.64
132 W	AIR	8.87	9.19	8.55	9.34	11.14	13.27	14.99	17.10	16.46	14.47	12.92	9.52
	SEA	10.00	9.78	9.32	9.58	10.95	13.00	14.98	17.25	17.20	15.54	13.52	11.22
	VPA	9.52	9.70	9.33	10.02	11.20	12.99	14.40	16.53	15.67	13.53	12.52	9.91
	VPS	12.34	12.16	11.78	12.01	13.12	15.05	17.09	19.75	19.67	17.72	15.56	13.38
	CLD	75.13	78.82	78.76	75.99	72.87	83.51	85.24	82.04	75.11	72.70	81.25	76.49
45 N	SPD	10.65	8.94	9.88	8.04	6.59	6.00	5.88	7.55	5.83	9.49	9.51	10.65
133 W	AIR	8.05	8.51	8.25	9.34	10.10	13.27	14.99	16.65	16.83	14.33	12.23	9.83
	SEA	9.87	9.24	9.42	9.05	10.46	12.80	14.96	16.83	16.98	15.15	13.23	11.30
	VPA	8.96	9.72	9.00	9.39	10.40	12.51	14.21	16.08	15.70	13.56	11.59	10.29
	VPS	12.23	11.70	11.86	11.56	12.71	14.83	17.08	19.21	19.41	17.26	15.26	13.45
	CLD	73.51	85.83	76.52	65.69	82.43	77.60	80.62	87.50	67.93	80.00	82.04	77.17

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
46 N	SPD	6.70	7.20	6.75	7.40	6.85	6.01	6.20	5.32	5.44	6.20	7.60	8.49
124 W	AIR	6.36	7.91	8.05	8.62	11.34	13.47	14.72	15.11	14.02	11.67	10.18	7.02
	SEA	8.13	9.05	9.23	9.89	11.58	13.16	13.98	14.37	13.78	12.34	10.73	9.13
	VPA	9.25	9.66	9.20	9.72	12.29	13.88	15.50	16.27	14.95	12.26	11.24	9.31
	VPS	10.89	11.55	11.69	12.20	13.68	15.19	16.02	16.46	15.80	14.40	12.92	11.62
	CLD	69.54	64.06	65.30	66.02	67.62	72.62	62.74	55.90	48.36	46.70	67.34	73.21
46 N	SPD	8.50	7.48	7.89	6.71	6.01	6.23	6.15	5.89	6.23	6.82	7.45	8.84
125 W	AIR	7.98	8.14	8.94	9.70	11.86	13.97	15.55	16.53	16.13	13.82	11.52	9.44
	SEA	9.38	9.23	9.47	9.96	11.82	14.35	15.21	16.33	15.84	14.10	12.28	10.61
	VPA	9.00	8.49	9.39	9.49	11.39	13.17	14.52	15.64	15.14	12.87	11.39	9.86
	VPS	11.83	11.69	11.89	12.29	13.92	16.44	17.37	18.71	18.12	16.16	14.35	12.84
	CLD	78.12	66.78	73.52	67.88	65.13	77.09	68.63	63.37	58.30	69.43	64.32	70.70
46 N	SPD	8.28	6.32	7.68	7.06	5.98	6.87	6.82	6.60	6.42	7.69	8.66	8.18
126 W	AIR	9.13	9.35	8.17	9.43	11.54	13.45	15.86	16.52	16.61	14.05	11.67	9.57
	SEA	9.20	9.59	9.51	10.09	11.52	13.52	15.94	17.27	16.76	14.87	12.21	10.53
	VPA	9.93	9.71	8.74	9.56	11.13	12.50	14.64	15.06	15.20	12.34	11.27	9.62
	VPS	11.69	12.08	11.92	12.48	13.66	15.59	18.17	19.76	19.13	16.98	14.30	12.78
	CLD	76.52	62.74	72.69	65.93	74.07	78.12	69.39	60.20	67.56	62.77	71.77	67.33
46 N	SPD	9.78	8.20	9.04	6.94	5.61	6.42	5.95	6.08	7.31	8.64	8.89	8.91
127 W	AIR	8.55	9.03	7.94	8.81	10.87	13.17	15.18	16.65	16.45	13.71	11.48	9.46
	SEA	9.60	9.45	9.32	9.37	11.09	13.80	15.36	17.31	17.38	15.09	12.67	10.64
	VPA	9.75	9.82	8.72	9.11	11.03	12.60	13.97	15.59	15.23	12.51	11.37	10.05
	VPS	12.00	11.91	11.78	11.80	13.26	15.90	17.54	19.83	19.92	17.23	14.69	12.88
	CLD	78.42	75.68	66.02	69.41	69.79	82.37	75.98	75.61	68.75	72.04	76.02	75.96
46 N	SPD	9.09	8.10	8.48	7.35	6.43	6.64	6.61	5.70	6.28	8.88	9.19	9.22
128 W	AIR	8.71	8.70	8.07	9.17	10.92	12.81	15.13	16.56	16.09	13.71	11.75	9.52
	SEA	9.86	9.20	8.88	8.87	11.03	13.07	14.92	17.02	16.89	14.62	12.96	11.12
	VPA	9.34	9.49	8.66	9.24	10.63	12.35	14.19	15.68	14.90	13.01	11.16	9.70
	VPS	12.22	11.69	11.44	11.42	13.19	15.08	17.05	19.51	19.32	16.71	15.00	13.29
	CLD	77.50	73.94	71.16	68.51	67.96	79.47	70.17	84.77	64.47	66.17	72.53	76.95
46 N	SPD	9.19	8.87	8.40	8.14	6.96	5.89	5.64	5.89	6.77	8.75	8.38	9.23
129 W	AIR	8.09	8.82	7.87	8.71	11.05	13.07	14.96	16.94	16.28	14.38	12.15	10.06
	SEA	9.54	9.39	8.86	8.89	10.77	12.94	14.84	17.22	16.92	15.23	12.99	10.84
	VPA	9.14	9.51	8.49	9.16	10.53	12.33	14.05	15.81	14.86	13.51	11.33	10.60
	VPS	11.97	11.85	11.42	11.43	12.98	15.01	16.96	19.73	19.34	17.37	15.03	13.03
	CLD	77.93	76.85	69.72	71.49	72.57	78.99	70.47	74.32	63.20	72.24	72.10	75.57
46 N	SPD	9.49	8.91	9.23	8.31	6.37	6.48	5.99	6.55	7.60	8.43	8.77	9.91
130 W	AIR	8.15	8.57	8.29	8.45	10.77	12.67	14.91	16.94	16.25	14.06	11.70	9.87
	SEA	9.62	9.28	8.89	8.80	10.28	12.72	14.90	16.64	16.92	14.84	12.93	11.02
	VPA	8.84	9.33	8.77	8.85	10.57	12.01	14.22	15.95	14.93	13.05	11.24	10.15
	VPS	12.01	11.74	11.43	11.36	12.56	14.76	17.01	18.99	19.34	16.95	14.95	13.19
	CLD	76.09	73.89	70.00	71.91	76.14	80.20	85.29	79.47	67.72	69.75	73.19	78.83
46 N	SPD	9.55	9.30	9.00	8.24	6.46	6.37	6.06	5.60	7.82	8.65	10.08	9.96
131 W	AIR	7.89	8.49	7.91	8.89	10.62	13.01	14.85	17.00	16.31	14.12	12.00	9.32
	SEA	9.28	8.93	8.51	8.65	10.16	12.62	14.66	16.77	16.40	14.94	12.89	10.63
	VPA	8.94	9.58	8.81	9.20	10.44	12.22	14.36	15.88	15.56	12.88	11.68	9.91
	VPS	11.75	11.50	11.15	11.27	12.49	14.70	16.77	19.16	18.73	17.07	14.92	12.88
	CLD	79.11	82.88	74.49	77.13	78.23	81.37	84.67	79.95	67.39	73.61	76.75	77.95
46 N	SPD	9.42	8.94	9.26	7.26	6.29	6.54	6.17	6.12	7.98	8.54	9.57	9.93
132 W	AIR	7.79	8.31	7.30	8.84	10.56	13.48	15.27	16.80	16.82	13.78	11.93	9.80
	SEA	8.38	9.29	8.82	8.80	10.00	12.34	14.76	16.70	16.59	14.76	13.01	10.84
	VPA	9.09	9.55	8.70	9.67	10.90	13.24	14.82	15.56	15.89	12.53	11.40	10.18
	VPS	11.08	11.77	11.38	11.37	12.40	14.43	16.89	19.08	18.94	16.85	15.04	13.05
	CLD	67.08	79.74	72.77	74.77	73.42	84.85	86.34	80.57	70.26	72.38	75.51	84.06
46 N	SPD	9.76	10.25	9.21	8.90	7.86	6.22	6.37	6.53	7.55	8.90	10.81	10.97
133 W	AIR	7.32	8.24	7.69	8.18	10.21	12.75	15.09	16.29	15.84	13.69	11.57	8.70
	SEA	9.21	8.61	8.40	8.73	9.64	12.10	14.46	16.56	16.27	14.68	12.59	10.43
	VPA	8.38	9.44	8.42	8.82	10.18	12.29	14.12	15.23	14.63	12.82	11.08	9.24
	VPS	11.69	11.23	11.06	11.31	12.03	14.19	16.52	18.91	18.59	16.78	14.65	12.68
	CLD	77.96	75.76	83.21	77.08	84.12	85.65	85.71	82.24	77.84	73.38	74.28	80.85

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
47 N	SPD	9.00	8.26	6.37	6.34	5.11	4.21	6.17	4.79	3.64	4.52	5.35	6.17
124 W	AIR	7.23	7.25	8.92	9.08	10.88	12.92	15.03	14.58	15.13	11.80	10.01	10.08
	SEA	8.24	8.58	9.62	10.00	10.75	12.75	13.21	13.43	15.06	12.34	10.19	11.28
	VPA	8.43	8.57	9.39	9.46	10.43	12.03	13.91	14.89	14.29	11.65	9.86	10.69
	VPS	10.97	11.21	12.01	12.30	12.99	14.81	15.28	15.49	17.17	14.48	12.46	13.39
	CLD	81.25	73.68	73.43	71.42	58.03	74.21	40.62	58.65	57.69	58.33	75.12	75.00
47 N	SPD	8.94	7.84	7.62	6.80	5.61	5.33	5.67	4.40	5.14	6.70	7.50	8.88
125 W	AIR	7.77	8.36	8.08	9.18	11.89	13.61	14.79	15.94	15.41	12.43	10.61	8.93
	SEA	9.11	8.86	9.08	9.69	11.69	13.77	14.26	15.89	15.02	13.01	11.53	10.05
	VPA	8.90	8.85	8.81	9.42	11.34	13.08	14.29	15.52	14.70	12.06	10.39	9.53
	VPS	11.61	11.43	11.59	12.06	13.82	15.82	16.36	18.16	17.20	15.06	13.65	12.38
	CLD	77.16	69.92	71.31	71.70	69.55	72.09	66.48	58.86	57.18	70.65	69.45	76.07
47 N	SPD	8.79	8.13	7.64	7.09	6.09	6.60	6.13	5.70	6.53	7.31	7.69	8.04
126 W	AIR	7.40	8.43	8.01	8.84	11.31	13.73	15.11	15.92	15.44	13.57	11.12	9.08
	SEA	9.10	8.77	8.40	9.12	11.21	13.35	14.93	16.33	15.91	13.82	11.57	10.08
	VPA	8.85	9.42	8.63	9.33	11.10	13.07	14.74	15.21	14.61	12.96	10.99	9.48
	VPS	11.62	11.35	11.04	11.61	13.37	15.42	17.06	18.66	18.20	15.87	13.68	12.42
	CLD	76.42	70.23	66.01	71.76	68.45	79.11	62.16	69.96	56.41	62.30	72.91	67.30
47 N	SPD	9.63	8.46	7.72	7.73	6.58	6.23	6.47	6.55	7.42	7.38	8.51	8.66
127 W	AIR	7.75	8.05	7.53	8.68	11.07	13.53	15.16	16.69	15.84	13.63	11.36	9.00
	SEA	9.06	9.07	8.58	8.87	11.06	13.50	15.33	16.82	16.00	14.00	12.00	10.10
	VPA	8.82	9.14	8.37	9.09	10.94	12.82	14.33	15.48	14.87	12.81	11.30	9.57
	VPS	11.57	11.61	11.21	11.42	13.25	15.54	17.50	19.22	18.29	16.08	14.09	12.41
	CLD	71.11	68.45	69.04	71.48	67.40	80.95	69.04	68.09	57.08	60.03	75.42	75.37
47 N	SPD	9.35	8.85	8.40	8.15	6.05	6.37	5.81	6.17	7.94	8.37	8.28	9.35
128 W	AIR	7.93	7.93	7.93	8.77	10.41	12.81	15.24	16.46	16.02	14.23	11.73	9.62
	SEA	8.93	8.49	8.51	8.72	10.46	13.16	15.43	16.91	16.55	15.21	12.91	10.53
	VPA	9.10	9.25	8.67	9.22	10.47	12.34	14.40	16.12	14.60	13.76	11.21	9.95
	VPS	11.47	11.13	11.14	11.31	12.77	15.23	17.58	19.32	18.91	17.33	14.98	12.78
	CLD	76.00	79.86	65.21	79.70	71.64	81.42	73.30	71.25	62.27	75.48	70.87	76.63
47 N	SPD	9.47	9.41	8.77	7.66	6.02	6.65	6.43	6.23	6.80	8.62	8.59	9.29
129 W	AIR	7.45	7.80	7.91	8.76	10.79	13.64	15.26	16.82	15.78	14.22	11.79	9.05
	SEA	9.00	8.08	8.27	8.74	10.35	12.38	14.50	17.00	16.77	15.19	12.81	10.32
	VPA	8.53	9.07	8.49	9.36	10.56	12.80	14.67	15.92	15.09	13.38	11.14	9.53
	VPS	11.52	10.85	10.97	11.32	12.61	14.47	16.56	19.46	19.17	17.31	14.91	12.58
	CLD	67.18	73.75	64.73	78.33	64.61	75.61	84.32	80.86	64.31	77.45	71.13	79.30
47 N	SPD	10.64	10.93	9.88	7.07	6.04	6.85	6.09	6.38	7.45	9.84	10.48	9.04
130 W	AIR	9.11	8.95	8.16	8.71	10.27	13.08	15.64	17.69	16.11	13.80	11.44	10.10
	SEA	10.03	10.05	9.23	8.55	10.00	12.56	15.39	17.11	17.20	15.39	12.46	10.98
	VPA	9.84	9.42	8.83	9.08	10.26	12.10	14.63	16.50	15.40	12.92	11.46	10.39
	VPS	12.33	12.39	11.68	11.16	12.33	14.59	17.53	19.57	19.66	17.56	14.50	13.13
	CLD	74.63	79.72	79.56	82.09	85.06	80.76	85.58	83.08	65.32	72.84	75.00	73.51
47 N	SPD	9.46	9.28	8.33	7.16	6.31	6.41	6.50	6.32	7.39	9.24	9.93	10.21
131 W	AIR	7.71	8.18	7.59	8.11	10.95	13.16	14.41	16.79	16.37	13.70	11.30	9.05
	SEA	8.96	8.30	8.41	8.00	10.23	12.63	14.19	16.93	16.95	14.48	12.43	10.44
	VPA	9.21	9.19	8.75	8.76	11.03	12.41	14.04	16.04	15.96	12.87	11.45	10.03
	VPS	11.48	10.99	11.10	10.76	12.52	14.71	16.26	19.36	19.38	16.57	14.48	12.70
	CLD	74.50	76.89	77.38	76.87	76.56	85.03	86.35	76.25	72.35	72.58	78.40	83.58
47 N	SPD	10.70	8.71	8.87	8.35	6.56	6.43	6.81	6.58	7.65	9.87	9.07	10.65
132 W	AIR	7.50	7.42	7.49	8.23	10.32	12.17	14.40	16.29	16.20	12.55	11.18	8.84
	SEA	8.66	8.00	8.11	7.97	9.99	11.10	14.27	16.21	16.36	14.54	12.13	10.04
	VPA	8.88	8.82	8.72	9.09	10.77	12.21	14.09	15.91	15.04	12.06	11.00	9.62
	VPS	11.26	10.76	10.86	10.73	12.35	13.31	16.34	18.53	18.68	16.67	14.20	12.39
	CLD	73.86	76.10	72.45	73.50	77.27	85.18	86.07	80.80	71.17	71.85	79.64	79.30
47 N	SPD	9.62	9.19	9.17	9.32	7.32	6.76	5.93	6.27	7.34	8.28	11.08	9.83
133 W	AIR	6.91	7.55	7.28	7.82	9.53	11.80	14.06	16.33	15.48	13.27	10.66	8.48
	SEA	8.23	8.07	7.69	8.00	9.17	11.47	13.47	16.09	15.70	14.47	11.79	9.94
	VPA	8.21	8.79	8.22	8.68	9.87	11.75	13.44	15.44	14.88	12.36	10.67	9.28
	VPS	10.95	10.83	10.54	10.76	11.67	13.62	15.51	18.36	17.89	16.54	13.88	12.30
	CLD	82.81	76.87	79.59	76.75	85.00	88.33	87.50	80.11	74.78	71.47	76.44	74.18

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
48 N	SPD	9.58	8.31	8.96	7.66	4.73	4.32	5.82	6.11	5.79	6.85	7.87	9.68
125 W	AIR	4.66	7.04	6.55	8.01	10.66	12.56	12.74	13.52	12.46	10.21	8.14	5.38
	SEA	8.37	8.68	8.55	9.08	10.48	12.08	12.41	13.35	13.09	11.48	10.29	8.79
	VPA	7.57	8.53	8.32	9.37	10.65	12.50	13.23	14.16	13.04	10.88	9.45	7.79
	VPS	11.02	11.26	11.17	11.56	12.72	14.18	14.48	15.39	15.15	13.65	12.56	11.35
	CLD	79.66	60.99	61.56	65.82	66.20	69.05	60.22	57.66	48.68	55.95	66.31	72.32
48 N	SPD	8.67	7.53	7.55	7.05	6.13	5.84	6.27	5.37	6.18	7.06	8.43	9.07
126 W	AIR	7.11	7.73	7.76	8.52	10.69	13.05	14.12	15.57	14.29	12.26	9.68	8.52
	SEA	8.58	8.38	8.04	8.93	10.75	12.38	13.97	15.02	13.79	12.69	10.52	9.58
	VPA	8.51	8.83	8.65	9.18	10.52	12.74	14.31	15.56	13.89	12.17	10.05	9.59
	VPS	11.20	11.05	10.80	11.46	12.98	14.45	16.02	17.20	15.87	14.77	12.82	11.98
	CLD	73.42	68.25	63.35	75.58	66.30	70.40	65.29	59.79	49.33	68.91	72.73	79.41
48 N	SPD	8.49	9.29	8.44	7.48	8.19	5.95	7.89	6.04	5.44	7.94	9.28	9.88
127 W	AIR	7.23	7.22	7.44	8.60	10.42	12.84	14.18	16.07	15.12	13.90	10.32	8.79
	SEA	8.47	7.98	7.97	8.71	10.02	12.29	14.18	15.63	15.74	14.17	11.44	9.95
	VPA	8.63	8.74	8.64	9.20	10.50	12.37	13.93	15.58	14.34	13.29	10.58	9.82
	VPS	11.15	10.76	10.77	11.38	12.36	14.36	16.25	17.87	17.99	16.34	13.57	12.27
	CLD	77.40	73.79	68.28	69.44	72.75	76.16	68.01	61.19	65.02	67.80	70.51	85.17
48 N	SPD	9.42	8.69	8.18	7.54	7.07	6.46	7.47	6.61	7.44	9.53	8.89	9.27
128 W	AIR	7.58	7.68	7.67	8.41	10.74	13.03	14.88	15.97	15.51	13.31	10.70	8.92
	SEA	8.41	8.34	8.07	8.62	10.36	12.64	14.63	15.94	15.90	13.58	11.64	9.72
	VPA	8.84	8.76	8.47	9.16	10.71	12.76	13.98	15.43	14.20	12.64	10.87	9.47
	VPS	11.07	11.02	10.81	11.25	12.64	14.70	16.75	18.21	18.16	15.64	13.76	12.10
	CLD	82.73	71.63	70.53	73.62	73.80	78.25	77.57	76.49	58.28	71.52	69.17	78.12
48 N	SPD	9.32	9.55	8.79	6.76	6.73	6.76	6.96	6.62	7.80	8.64	9.87	9.16
129 W	AIR	6.81	7.32	7.23	8.48	10.58	12.42	14.81	16.44	15.66	13.59	10.54	8.33
	SEA	8.60	7.92	7.68	8.40	10.21	12.38	14.60	16.32	15.88	13.94	11.93	9.81
	VPA	8.37	8.82	8.51	9.11	10.49	12.12	14.08	15.90	14.81	13.11	10.45	9.32
	VPS	11.21	10.71	10.53	11.06	12.52	14.46	16.67	18.66	18.14	15.98	14.04	12.17
	CLD	82.06	75.93	75.79	77.23	74.85	78.69	78.84	78.54	64.50	77.21	73.66	80.33
48 N	SPD	9.03	9.63	8.23	7.55	6.92	6.22	6.97	6.50	7.65	9.42	10.21	9.64
130 W	AIR	6.99	7.20	7.22	8.49	9.91	12.00	14.15	16.41	15.65	13.18	10.87	8.29
	SEA	8.37	7.94	7.95	8.36	9.65	11.99	14.18	16.14	15.81	13.99	11.68	10.04
	VPA	8.48	8.66	8.53	9.05	10.10	11.84	13.49	15.43	14.52	12.39	10.87	9.15
	VPS	11.03	10.75	10.72	11.04	12.06	14.12	16.25	18.44	18.05	16.06	13.80	12.37
	CLD	78.42	74.79	69.00	72.67	69.44	80.38	78.98	78.47	69.82	71.83	83.03	76.61
48 N	SPD	11.06	9.11	8.10	7.35	6.45	6.24	5.53	6.48	7.61	8.64	10.00	10.06
131 W	AIR	7.42	7.41	7.25	8.07	10.24	12.30	14.83	16.44	15.41	13.15	10.49	8.34
	SEA	8.32	7.43	7.69	7.99	9.61	11.84	14.44	16.44	15.78	13.86	11.79	9.57
	VPA	8.95	8.75	8.48	8.78	10.50	12.46	14.24	15.88	14.56	12.61	10.49	9.42
	VPS	10.99	10.36	10.53	10.75	12.03	13.97	16.55	18.78	18.00	15.93	13.89	11.97
	CLD	77.56	75.32	74.51	76.37	73.92	83.46	81.07	82.65	70.49	77.14	77.89	77.23
48 N	SPD	8.80	9.68	7.83	7.39	6.19	6.20	6.40	6.31	8.03	8.43	9.94	9.73
132 W	AIR	7.11	6.97	7.10	7.98	9.84	12.69	14.30	15.98	15.57	13.51	10.78	8.18
	SEA	7.77	7.08	7.08	7.56	9.26	11.63	13.92	16.04	15.93	14.00	11.66	9.51
	VPA	8.29	8.37	8.33	8.96	10.32	12.34	13.99	15.59	15.05	12.46	10.68	9.08
	VPS	10.58	10.10	10.12	10.44	11.72	13.75	15.99	18.34	18.18	16.07	13.79	11.94
	CLD	75.59	83.43	75.42	74.12	76.59	83.86	88.93	87.93	78.82	71.55	76.04	77.38
48 N	SPD	8.89	9.65	9.38	8.06	6.65	6.51	5.75	6.81	8.08	8.98	10.08	10.82
133 W	AIR	6.71	7.05	6.81	7.71	8.99	11.80	13.70	15.23	15.22	12.11	9.84	7.11
	SEA	8.06	7.28	7.52	7.70	8.87	11.25	13.32	15.37	15.28	13.22	11.16	8.96
	VPA	7.95	8.51	8.11	8.36	9.62	11.77	13.30	14.72	14.36	11.63	10.07	8.28
	VPS	10.82	10.27	10.41	10.55	11.45	13.41	15.36	17.52	17.45	15.26	13.33	11.49
	CLD	72.91	76.59	75.88	72.72	81.25	86.12	86.12	85.30	74.21	72.47	79.64	74.53
48 N	SPD	9.27	10.22	9.39	7.98	6.55	6.88	4.73	7.04	8.71	9.46	10.11	11.16
134 W	AIR	5.78	6.55	6.22	7.40	9.55	11.89	14.11	14.92	14.66	13.06	10.07	7.80
	SEA	7.50	7.27	7.26	7.38	8.58	10.91	13.55	15.04	14.88	13.30	11.09	8.71
	VPA	7.52	8.26	7.44	8.32	9.89	11.75	13.29	14.51	14.18	12.47	10.25	8.91
	VPS	10.40	10.23	10.24	10.32	11.19	13.11	15.57	17.17	16.98	15.33	13.26	11.31
	CLD	77.03	76.17	72.91	74.02	82.79	85.03	84.69	82.86	77.04	77.50	72.23	80.92

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
49 N	SPD	10.65	7.91	8.26	7.44	5.93	5.67	6.29	5.29	5.66	7.25	7.20	8.59
126 W	AIR	6.24	7.94	7.10	8.42	11.21	12.28	14.46	14.75	13.47	11.87	9.20	7.73
	SEA	8.28	8.69	8.04	8.74	10.42	11.85	12.91	13.64	13.42	11.57	10.40	9.33
	VPA	8.04	9.07	8.49	9.24	10.95	12.33	14.26	14.79	13.11	11.69	9.73	9.03
	VPS	10.97	11.27	10.80	11.31	12.69	13.94	14.97	15.74	15.50	13.71	12.68	11.79
	CLD	79.72	75.98	70.27	62.06	62.89	66.79	55.33	56.78	58.70	66.50	60.00	75.54
49 N	SPD	8.93	8.09	8.53	7.95	6.63	6.47	6.65	6.52	6.90	7.61	8.01	9.21
127 W	AIR	6.47	7.37	7.32	8.46	10.91	13.11	14.32	15.44	14.38	12.45	10.11	7.94
	SEA	8.35	7.78	7.96	8.66	10.45	12.33	13.36	14.53	14.15	12.77	10.81	9.26
	VPA	8.07	8.49	8.46	9.10	10.83	12.49	14.23	15.29	14.05	12.29	10.10	8.92
	VPS	11.01	10.61	10.75	11.25	12.72	14.40	15.40	16.63	16.26	14.82	13.03	11.72
	CLD	66.72	71.08	70.68	67.11	63.76	63.34	60.08	56.25	58.66	70.29	72.87	68.82
49 N	SPD	9.83	9.34	8.66	8.27	7.90	7.21	7.39	6.70	7.49	8.81	8.95	9.65
128 W	AIR	6.88	7.27	7.13	8.39	10.56	12.36	14.27	15.82	14.75	12.79	9.78	7.81
	SEA	8.08	7.98	7.76	8.20	10.47	11.80	14.05	15.44	14.80	13.00	10.86	9.14
	VPA	8.53	8.63	8.53	9.08	10.48	11.78	14.14	15.56	14.22	12.21	9.89	9.08
	VPS	10.82	10.75	10.60	10.91	12.72	13.88	16.09	17.63	16.92	15.04	13.06	11.64
	CLD	79.00	72.47	77.69	72.36	74.25	73.05	70.04	68.18	62.11	68.52	72.87	75.65
49 N	SPD	9.42	8.50	8.77	8.04	6.75	6.92	6.84	6.78	7.38	9.28	8.97	9.85
129 W	AIR	6.31	7.39	7.24	7.96	10.15	12.29	14.50	15.92	14.80	12.63	10.27	8.15
	SEA	7.91	7.65	7.58	7.91	9.97	12.02	14.17	15.53	15.07	13.27	11.38	9.25
	VPA	8.19	8.52	8.53	8.81	10.31	12.07	13.95	15.57	14.15	11.80	10.26	9.10
	VPS	10.70	10.51	10.47	10.70	12.30	14.11	16.21	17.69	17.19	15.33	13.50	11.71
	CLD	74.15	76.81	69.98	69.89	76.12	77.21	76.30	73.56	64.70	68.41	71.01	82.88
49 N	SPD	10.77	10.45	8.41	8.65	6.64	6.52	6.58	7.10	7.99	8.58	8.66	10.56
130 W	AIR	6.95	7.43	7.29	8.07	9.97	11.94	14.15	15.80	15.21	12.88	10.56	8.17
	SEA	8.56	7.90	7.62	7.88	9.41	11.56	13.64	15.58	15.13	13.32	11.57	9.36
	VPA	8.42	8.78	8.32	8.79	10.08	11.83	13.79	15.13	14.28	12.33	10.48	8.99
	VPS	11.18	10.71	10.50	10.67	11.84	13.67	15.68	17.77	17.26	15.34	13.71	11.79
	CLD	77.36	73.70	72.59	73.36	77.09	81.04	79.16	76.13	70.65	73.27	77.00	73.83
49 N	SPD	10.33	10.13	9.34	8.85	6.91	6.03	6.63	7.22	7.82	8.35	8.86	9.78
131 W	AIR	7.00	7.36	7.14	8.09	9.66	12.10	13.94	15.49	14.77	13.12	10.25	8.43
	SEA	8.43	8.44	7.55	7.73	9.29	11.48	13.67	15.36	14.98	13.45	11.62	9.43
	VPA	8.58	8.66	8.08	8.93	9.79	11.75	13.47	15.05	14.09	12.55	10.21	9.27
	VPS	11.09	11.09	10.43	10.56	11.75	13.58	15.69	17.51	17.08	15.48	13.75	11.85
	CLD	80.37	79.18	72.77	79.39	72.89	82.51	84.49	81.90	73.98	73.10	73.02	74.76
49 N	SPD	10.09	10.12	9.22	8.27	6.68	7.01	6.23	7.10	8.16	9.57	9.41	9.77
132 W	AIR	6.11	6.76	6.69	7.27	9.40	11.22	14.04	15.36	14.89	12.44	9.81	7.66
	SEA	7.66	7.35	7.17	7.32	8.72	10.93	13.43	15.35	14.77	13.19	10.87	8.84
	VPA	7.83	8.26	8.10	8.37	9.79	11.60	13.69	14.84	14.27	12.12	9.96	8.76
	VPS	10.51	10.30	10.19	10.27	11.32	13.12	15.48	17.52	16.90	15.26	13.07	11.40
	CLD	79.53	79.12	74.12	71.69	79.41	85.66	82.91	78.94	75.26	73.69	72.50	80.54
49 N	SPD	9.92	10.38	9.50	8.68	7.06	6.80	5.97	7.31	8.01	8.67	10.52	10.53
133 W	AIR	5.92	6.48	6.37	7.20	8.77	10.91	13.57	15.23	14.62	12.32	9.91	7.50
	SEA	7.55	6.78	6.85	7.20	8.53	10.65	13.33	15.33	14.76	13.02	10.87	9.05
	VPA	7.80	8.46	7.83	8.44	9.63	11.13	13.33	14.95	14.31	11.87	10.33	8.68
	VPS	10.44	9.90	9.95	10.18	11.17	12.91	15.38	17.49	16.85	15.06	13.07	11.58
	CLD	79.48	83.11	72.61	75.08	77.61	85.25	87.19	84.33	71.91	71.74	73.31	75.93
49 N	SPD	10.01	9.69	9.49	8.66	6.26	7.04	6.12	6.74	8.00	9.94	10.73	10.23
134 W	AIR	6.10	6.50	6.01	6.80	8.80	10.85	13.31	15.14	14.40	11.85	9.45	7.25
	SEA	7.43	6.83	6.84	7.02	8.27	10.51	13.11	14.99	14.30	12.39	10.50	8.66
	VPA	7.98	8.08	7.84	8.02	9.46	11.10	13.27	14.88	13.71	11.45	9.79	8.42
	VPS	10.35	9.95	9.95	10.06	10.98	12.76	15.16	17.13	16.38	14.46	12.76	11.25
	CLD	79.32	77.72	74.40	69.89	78.35	86.38	86.69	85.14	74.02	73.34	77.05	78.79
49 N	SPD	10.10	9.93	9.43	8.12	7.08	6.86	6.16	7.00	8.78	9.32	10.13	10.05
135 W	AIR	5.39	6.13	6.23	6.88	8.69	10.82	13.08	14.71	14.25	12.11	9.34	7.40
	SEA	7.21	6.80	6.60	6.83	8.29	10.21	12.71	14.62	14.33	12.46	10.46	8.79
	VPA	7.47	8.02	7.99	8.19	9.56	11.24	13.12	14.54	13.83	11.89	9.74	8.68
	VPS	10.20	9.91	9.78	9.93	10.99	12.54	14.78	16.70	16.38	14.52	12.72	11.36
	CLD	81.98	81.00	78.00	80.48	81.25	89.22	89.41	84.14	77.50	77.26	76.20	75.56

LAT/LON		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
50 N	SPD	7.26	9.33	8.27	7.57	5.84	4.41	6.04	3.83	5.50	7.39	9.99	8.69
127 W	AIR	6.12	7.75	7.33	8.48	10.31	11.86	14.67	13.74	12.88	11.10	7.21	7.57
	SEA	7.18	7.25	6.64	8.55	10.48	11.38	13.68	11.31	10.80	10.44	9.72	7.42
	VPA	7.83	9.05	7.70	8.39	9.43	11.29	14.31	13.08	12.91	10.61	8.74	8.12
	VPS	10.22	10.22	9.81	11.17	12.78	13.60	15.83	13.59	13.14	12.78	12.07	10.39
	CLD	88.88	87.50	70.19	68.75	64.77	88.54	57.89	73.43	63.58	78.57	83.33	81.25
50 N	SPD	9.79	9.17	7.92	8.19	6.53	7.38	6.71	6.22	6.80	7.08	7.57	10.31
128 W	AIR	6.19	7.00	7.71	7.99	10.16	12.70	13.81	15.79	13.86	11.88	9.56	7.63
	SEA	8.24	8.13	8.10	8.84	10.46	12.26	13.19	14.22	13.15	11.97	10.76	9.10
	VPA	8.06	9.10	8.39	8.71	10.32	11.90	13.87	15.53	13.42	11.85	10.00	8.72
	VPS	10.94	10.87	10.83	11.39	12.72	14.34	15.25	16.38	15.21	14.11	12.95	11.61
	CLD	82.42	78.80	83.92	69.81	65.00	61.88	63.55	51.63	55.95	71.68	74.77	74.64
50 N	SPD	9.32	9.14	8.90	9.20	6.25	7.65	7.22	6.46	7.89	8.64	9.17	9.02
129 W	AIR	7.01	7.54	6.80	7.87	10.31	12.45	14.28	15.48	14.54	12.02	9.18	6.89
	SEA	8.36	7.95	7.74	8.51	9.93	12.26	13.79	15.04	14.30	12.50	10.40	8.79
	VPA	8.41	8.82	8.29	8.76	10.23	12.23	13.82	15.19	14.12	11.83	9.79	8.21
	VPS	11.04	10.73	10.59	11.14	12.28	14.35	15.86	17.19	16.39	14.55	12.66	11.36
	CLD	79.77	78.92	78.62	68.13	67.41	79.43	67.13	74.87	65.43	64.85	79.16	77.55
50 N	SPD	10.05	9.23	9.22	7.87	7.02	6.62	6.67	7.16	7.86	8.45	9.53	8.59
130 W	AIR	6.79	7.16	7.07	8.07	9.62	11.71	13.90	15.58	14.77	12.34	10.08	7.93
	SEA	8.46	7.83	7.74	8.22	9.73	11.56	13.74	15.18	14.80	13.25	11.05	9.36
	VPA	8.46	8.58	8.23	8.79	10.00	11.88	13.70	14.98	14.62	12.14	10.38	9.23
	VPS	11.12	10.65	10.57	10.94	12.11	13.68	15.77	17.34	16.90	15.28	13.22	11.79
	CLD	82.99	80.74	76.22	73.06	70.52	81.48	79.87	77.15	68.04	73.25	77.02	83.56
50 N	SPD	9.59	10.17	9.31	7.84	6.89	6.11	6.36	6.69	7.85	8.94	9.53	9.90
131 W	AIR	6.77	7.12	6.76	7.61	9.62	11.82	13.86	15.44	14.70	12.58	9.95	8.00
	SEA	8.44	8.04	7.49	8.13	9.51	11.54	13.58	15.36	14.83	13.19	10.99	9.12
	VPA	8.20	8.45	8.11	8.76	9.81	11.52	13.52	15.11	14.27	12.21	10.08	9.23
	VPS	11.10	10.79	10.40	10.85	11.93	13.65	15.62	17.52	16.92	15.21	13.18	11.63
	CLD	74.26	75.33	74.55	71.59	73.12	82.74	81.40	80.90	73.60	75.68	76.62	72.33
50 N	SPD	9.27	8.86	8.88	7.61	6.57	6.59	6.22	6.27	7.85	9.78	10.31	9.96
132 W	AIR	6.04	6.60	6.05	7.46	8.94	11.16	13.26	15.31	14.48	12.11	9.40	6.99
	SEA	7.58	7.31	7.20	7.45	9.17	11.03	13.36	15.31	14.70	12.83	10.56	8.67
	VPA	7.82	8.54	7.77	8.48	9.62	11.53	13.08	14.79	13.97	11.90	9.85	8.66
	VPS	10.45	10.28	10.18	10.38	11.65	13.22	15.38	17.47	16.80	14.86	12.82	11.26
	CLD	81.06	80.57	76.19	71.42	75.32	84.88	84.28	77.48	68.93	76.93	78.21	68.75
50 N	SPD	9.29	10.38	9.45	7.97	7.10	6.90	6.14	6.62	8.17	9.13	10.48	11.43
133 W	AIR	6.01	6.21	6.32	6.96	8.93	11.33	13.27	15.00	14.27	12.02	9.38	7.31
	SEA	7.64	7.17	6.98	7.42	8.90	10.97	13.23	14.88	14.39	12.81	10.19	8.40
	VPA	7.89	8.17	7.96	8.29	9.47	11.50	13.38	14.54	13.75	11.43	9.79	8.60
	VPS	10.50	10.17	10.03	10.36	11.44	13.15	15.27	16.98	16.46	14.85	12.50	11.07
	CLD	82.61	79.10	75.97	70.79	77.18	85.99	85.52	79.16	70.99	70.56	79.00	79.72
50 N	SPD	10.96	9.16	8.11	8.42	7.13	6.72	4.92	6.87	7.95	9.83	10.42	10.72
134 W	AIR	6.29	7.11	6.54	7.01	8.88	11.14	13.43	14.91	14.02	12.04	8.58	7.10
	SEA	8.60	7.45	7.13	7.05	8.70	10.33	13.12	15.24	14.13	12.65	10.57	9.18
	VPA	8.33	8.52	7.94	8.19	9.42	11.51	13.04	14.56	13.10	11.63	9.34	8.64
	VPS	11.23	10.37	10.12	10.08	11.30	12.59	15.16	17.39	16.18	14.69	12.81	11.66
	CLD	80.12	79.69	73.59	74.85	81.25	89.00	82.25	82.23	72.14	76.00	76.02	77.78
50 N	SPD	10.58	10.29	9.32	8.68	7.45	6.76	5.63	6.61	8.97	9.90	10.39	10.09
135 W	AIR	5.77	6.29	6.13	6.73	8.31	10.48	12.87	14.81	15.00	11.86	9.18	6.76
	SEA	7.05	6.92	6.77	6.94	8.36	10.38	12.67	14.71	14.99	12.56	10.39	8.25
	VPA	7.65	8.06	7.81	8.16	9.15	11.06	12.96	14.52	14.42	11.34	9.69	8.11
	VPS	10.09	9.99	9.90	10.01	11.07	12.66	14.72	16.81	17.11	14.62	12.66	10.95
	CLD	77.28	81.82	68.91	70.42	78.69	89.74	89.98	85.00	74.66	73.02	76.98	78.44
50 N	SPD	9.84	10.33	8.37	9.17	7.97	7.59	5.41	6.69	8.47	10.01	10.98	11.08
136 W	AIR	6.18	6.30	6.22	6.56	8.02	11.22	12.67	14.60	13.78	11.70	8.56	7.27
	SEA	7.47	7.64	7.21	6.51	8.32	10.89	12.39	14.28	14.06	12.60	9.76	8.10
	VPA	7.78	8.30	8.01	7.83	8.72	11.34	12.56	14.14	13.30	11.42	8.86	8.73
	VPS	10.39	10.51	10.18	9.71	11.03	13.08	14.43	16.35	16.10	14.69	12.12	10.82
	CLD	77.36	80.64	79.72	79.05	82.05	90.02	92.14	86.73	76.57	77.25	78.50	83.00

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